State of California
THE RESOURCES AGENCY
Department of Water Resources

BULLETIN No. 143-1

SAN LORENZO RIVER WATERSHED WATER QUALITY INVESTIGATION

JUNE 1966

HUGO FISHER
Administrator
The Resources Agency

EDMUND G. BROWN
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PREFACE

Justice Oliver Wendell Holmes once said, "---- a river is more than an amenity, it is a treasure." Let us recognize the San Lorenzo River system as the treasure it is. Let us neither hoard it nor squander it. Let us use it prudently, invest it wisely, and enjoy the bountiful interest it will yield.

FOREWORD

Bulletin No. 143-1, "Water Quality Investigation, San Lorenzo River Watershed, Santa Cruz County", is the result of a two-year Department of Water Resources investigation authorized by Section 229 of the Water Code.

The report concludes that even though the present quality degradation has not been alarming, an effective water quality management program is needed now because of the expected increase in residential development and recreational demand. Based on these conclusions, the report recommends the establishment of an Advisory Committee made up of interested agencies to recommend and to stimulate interest in the necessary measures to protect the waters of the San Lorenzo River watershed.

William E. Warne

William E. Warne, Director
Department of Water Resources
The Resources Agency
State of California
April 18, 1966

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ACKNOWLEDGMENTS

Valuable assistance was supplied during the course of this investigation by the City of Santa Cruz Water Department; the Santa Cruz County Health Department; the Santa Cruz County Planning Commission; the State Departments of Fish and Game and Public Health; the Central Coastal Regional Water Quality Control Board;* and individuals representing the numerous water supply systems in the study area.

The help of these agencies and individuals is greatly appreciated by the California Department of Water Resources.

*Prior to September 17, 1965, the Central Coastal Regional Water Pollution Control Board.

ABSTRACT

The present quality of the surface and ground water in the San Lorenzo River watershed is generally good, although the ground water in some areas, notably Scotts Valley, often has a high iron content.

However, an effective water quality management program is needed now because of the expected increase in residential development and recreational demand. The Department of Water Resources recommends the establishment of an Advisory Committee representing the interested agencies to recommend, and to stimulate interest in, the necessary measures to protect the water of the San Lorenzo River watershed.

The water in the watershed is used mainly for municipal, domestic, and recreational purposes. Nearly 90% of the total annual rainfall at Santa Cruz occurs in the six-month period from November to April, and most of the runoff occurs from December to May. Since the mineral quality of water improves with increased flow, the best quality water is gone by the time the summer vacation season arrives.

Potential water quality problems in the watershed are sewage disposal and erosion, both natural and that caused by the aggregate and logging industries. Also, as the valley becomes more fully developed, conflicts of interest could arise between recreationists and water service agencies, or between fishing interests and industrial water users. Water use priorities may have to be assigned.

Applicable water quality management techniques include construction of dams and reservoirs, close control of waste discharges, and installation of erosion control projects.

CHAPTER I. INTRODUCTION

The San Lorenzo River watershed is an area of contradiction and contrast. Periodically, it overflows with recreationists and sightseers, yet much of the area retains an atmosphere of unspoiled wilderness, aloof from man. A redwood tree, full grown when Columbus set sail, towers over a bikini-clad teenage blond basking on the beach; and nearby a redhead competes with a rainbow trout for a fisherman's attention.

The San Lorenzo River watershed is an area of inconsistency. Generally, ground water is more mineralized than surface water, but the ground water in the Santa Margarita sands is the least mineralized of any water in the area. It is of even better quality than the excellent water in Clear Creek, a sparkling stream which flows through the dining room of a resort hotel.

The San Lorenzo River also is a paradox. Generally, a river is more mineralized near its mouth than near its source, but the often muddy water near the mouth of the San Lorenzo River has a lower mineral content than the clear-flowing brook which is the river's headwaters. The San Lorenzo River supports heavy recreational use and a substantial population along nearly its entire length, yet near its mouth it yields a good quality water which is treated for municipal use by the City of Santa Cruz.

In short, this Alice-in-Wonderland watershed suggests a riddle. So let us proceed to solve it.

Area of Investigation

The drainage area of the San Lorenzo River watershed extends from the river's source near the southern boundary of San Mateo County to its mouth in the City of Santa Cruz on Monterey Bay (Plate 1). The basin is bounded on the west by Ben Lomond Mountain and on the east by the Santa Cruz Mountains. The watershed in general has a steep rugged topography consisting of forest lands, but most of the habitation is along the streambeds where the land is relatively flat. Elevations vary from sea level to about 3,200 feet over the watershed area of 152 square miles. In the valleys, there are more than 40 separate communities, most of which are small. Except for the City of Santa Cruz, none of the communities is incorporated.

The San Lorenzo Valley, in addition to being a popular recreation and resort area for a number of years, has become an increasingly popular area for construction of subdivisions for both summer and permanent homes. Since 1956, 42 percent of all new subdivisions proposed in Santa Cruz County have been located within the San Lorenzo River watershed, which constitutes one-third of the total county area.

Current summer population in San Lorenzo Valley, upstream from the City of Santa Cruz, is estimated to be about 30,000. The permanent population is much less. Santa Cruz, at the mouth of San Lorenzo Valley, has a population of approximately 37,000. Both of these populations are expected to increase rapidly because of the favorable climate and scenic attractiveness of the area and also because of the new University of California campus on the northern edge of Santa Cruz.

The mild and equitable climate of the Santa Cruz-San Lorenzo Valley area is favorable to the productivity of its agricultural lands and to the establishment of home sites and resorts. It is characterized by dry summers and wet winters, with nearly 90 percent of the seasonal precipitation occurring during the six months from November through April. The year-around average temperature at Santa Cruz is 57.2°F. Precipitation occurs almost entirely in the form of rain and varies in long-term seasonal amounts from over 60 inches per year on Ben Lomond Mountain to less than 26 inches per year near Santa Cruz.

Objectives of Investigation

The San Francisco Bay District of the Department of Water Resources plans to supplement its basic network of surface, ground, and waste water sampling by more comprehensive periodic investigations of each of the major watersheds within the District. These investigations will be continued on a rotating basis so that each watershed will be investigated comprehensively for trends or changes in water quality about once every 10 or 12 years. These investigations, however, would be paramount in value if they resulted in the ability to predict and--if necessary--control future trends in water quality. Such ability could result from a well-planned and well-executed water quality management program. This investigation and report is the first attempt by the Department of Water Resources to recommend and to aid in the implementation of a water quality management plan for an entire watershed. It is hoped that this prototype will succeed--or even point the way to success--so that it may be used as a guide in future management programs for larger, more complex watersheds in other areas.

Specific objectives of this water quality investigation include the following:

1. Determine the present quality of water in various reaches of the main stem and in all the substantial tributaries of the San Lorenzo River, including the seasonal or other fluctuations in such quality.

2. Determine the sources and magnitude of present degradation of water quality within the watershed.

3. Define objectives or goals for specific parameters of water quality.

4. Determine the minimum continuing water quality monitoring program necessary to detect any future changes in quality of waters in the San Lorenzo River watershed.

5. Advise interested agencies on future water quality management practices, including recommendations for attaining specific water quality objectives.

6. Identify an appropriate organization with basinwide authority to execute a water quality management program.

Potential Problems

Until recently in the San Lorenzo River watershed, there were no community sewerage systems for any of the towns upstream from the City of Santa Cruz. Recently, however, four small sewerage systems have been constructed to serve new subdivisions in the unincorporated area of the watershed. These systems collect and treat domestic sewage and then dispose of it directly underground or by spray disposal to land. With the rapidly expanding population, the growth of such disposal systems, unless properly planned, together with the existing septic tanks and leaching fields, may result in substantial seepage of sewage effluent into the San Lorenzo River and its tributaries. Although this seepage, after traveling through the soil for some distance, might not create a health hazard, it possibly could degrade the mineral quality of the natural stream flow. Nutrients, in excess of the amount required by fishlife, may be released. These nutrients, together with the proper combination of other factors--chiefly, water velocity and temperature--could result in nuisance blooms of floating algae and attached growths on the stream bottoms.

Natural erosion and channel disturbances associated with sand mining and sand and gravel processing plants have resulted in a silting problem, especially in the Zayante Creek watershed, which is tributary to the lower reach of the San Lorenzo River. At times, the silt has adversely affected aquatic life and detracted from esthetic enjoyment in the watershed. In addition, high turbidities have caused problems in the treatment of surface water for domestic and municipal use. Future acceleration of building and road construction, subdivision developments or logging activities may intensify this silting problem.

Problems associated with population growth and increasing water demands may lead to conflicts of interest among the varied water uses. Competitive and often inharmonious uses of San Lorenzo River water include domestic and municipal, industrial, and recreational uses including esthetic enjoyment and fish propagation. Some interests may even demand that the river water be used to transport sewage and other waste materials. The satisfactory solution of future quality problems entails insuring that one water use does not unreasonably devaluate the water for other uses. This may necessitate giving priority to those water uses which yield the greatest benefit.

Scope of Investigation

Because of the many facets of water quality involved, an attempt was made to make this a more comprehensive investigation by soliciting the aid of several agencies representing the varied disciplines of water quality. The State Department of Fish and Game provided a summary of the fishery resources of the San Lorenzo River watershed and was helpful in the interpretation of water quality criteria for aquatic life. The State Department of Public Health, Bureau of Sanitary Engineering, and the Santa Cruz County Department of Public Health assisted by collecting and evaluating bacteriological data to supplement their earlier work in this area. The City of Santa Cruz supplied considerable antecedent data on the quality of its raw water supply. It also provided a history of the problems associated with the opening of Newell Creek Reservoir (Loch Lomond). Staff members of the Central Coastal Regional Water Quality Control Board assisted in the follow-up or review of waste discharge requirements particularly with respect to concepts new to the area, such as spray disposal to land of treated sewage effluent. They were also helpful in the study of the sand mining plants in the Zayante-Bean Creek area.

Field work consisted of approximately 13 months of sampling as well as reconnaissance inspections and interviews with local residents and agencies. Approximately 24 surface water stations and 5 ground water sources were sampled for physical and chemical quality. Most of the surface water stations were sampled on a monthly basis. The samplings included field determinations of temperature, hydrogen-ion concentration (pH), dissolved oxygen, and specific conductance. Samples were also obtained for laboratory determinations which generally included specific conductance, hardness, alkalinity, chloride, alkyl benzene sulfonate (ABS) detergent, phosphate, nitrate, and turbidity. In addition, spot checks were made for a wider range of quality parameters, including heavy metals (particularly iron), color, suspended solids, total nitrogen, insecticides, and biochemical oxygen demand. The County Health Department collected and analyzed samples monthly throughout the summer at 16 stations on the San Lorenzo River and its tributaries for coliform densities.

Geological work was limited to a brief reconnaissance survey of the area to complete the geologic mapping by supplementing available antecedent data.

Related Investigations and Reports

All references used in connection with this study are listed in Appendix A. Direct reference in the text to a particular publication or report is indicated by means of a number in parentheses, for example, (1). References that directly discuss the San Lorenzo River watershed are the following:

6. California State Department of Public Health, Bureau of Sanitary Engineering. "Report on Survey of San Lorenzo River, Santa Cruz County", June 1961 and July 1962.

7. California State Department of Public Health, Bureau of Sanitary Engineering. "San Lorenzo Valley Water Uses", mimeographed report 1963.

8. California State Department of Public Works, Division of Water Resources. "Geology and Hydrology of Santa Margarita Formation, San Lorenzo River". Water Quality Investigations, 1951. A contribution to a report published by the Bureau of Sanitary Engineering for the Central Coastal Regional Water Pollution Control Board.

10. California State Department of Water Resources, Bay Area Branch. "Erosion Studies-San Lorenzo Valley, Santa Cruz County". A memorandum to the Central Coastal Regional Water Pollution Control Board dated March 1, 1963.

12. California State Department of Water Resources, Division of Resources Planning. "Sedimentation Studies - Zayante and Bean Creeks, Tributaries of San Lorenzo River, Santa Cruz County". A memorandum to the Central Coastal Regional Water Pollution Control Board dated September 4, 1958.

13. California State Water Resources Board. "Santa Cruz-Monterey Counties Investigation". Bulletin No. 5. August 1953.

CHAPTER II. WATER USE

The nature and extent of water use in the San Lorenzo River Basin, both now and in the future, are considered in this chapter. Various water uses, listed in approximate order of importance to the watershed, are as follows: (1) municipal and domestic use, (2) recreation, including fish propagation and esthetic enjoyment, (3) industrial use, (4) agriculture, and (5) waste transport.

Municipal and Domestic Use

Municipal and domestic water is supplied by about fifty individual water service systems. All but one of these water systems obtain their water from sources within the watershed, and the systems serve from as few as 3 to as many as 14,000 customers. The one exception is the City of Santa Cruz, which obtains part of its supply from coastal streams and springs. Table 1 lists these water supply systems along with their water sources, number of service connections, and treatment provided. The identification numbers refer to Plate 2, which shows the locations of the water sources for each supply system.

City of Santa Cruz

The major user of surface water for municipal purposes in the study area is the City of Santa Cruz. The city presently obtains water from three sources: coastal springs and creeks, the San Lorenzo River, and a reservoir on Newell Creek which is a tributary to the river.

The coastal sources presently furnish water to the Santa Cruz distribution system by gravity during most of the year. In addition to supplying the city, the pipeline carrying water from the coastal sources to the city is tapped at several points to provide irrigation water for farms along the coast.

TABLE 1

DOMESTIC WATER SUPPLY SYSTEMS IN THE SAN LORENZO VALLEY

Identification Number	System	Source(s) of Supply	Number of Service Connections	Treatment
25	Academy Drive Water Co.	Spring	5	none
12	American Utilities Inc.	Springs and Bear Creek	56	F, Cl_2
44	T. J. Armstrong	Well	4	none
48	Assemblies of God MWC	Well, Carbonero Creek, Scotts Valley College County Water District	200 + College	F, Cl_2
6	Big Basin Water Co.	Springs	228	none
18	Big Redwood Park Water and Improvement Association	2 Springs and Well	30	Cl_2
8	Braken Brae MWC	Sand Creek	25	none
41	J. Brehm Water System	Well	5	S, F
10	Citizens Utility Company	Pee Vine, Forman, Harmon, Clear, Sweetwater, Fall, Bull Creeks, Bennet, Coon Springs + Wells	3,728	Cl_2 all, Filter Wells
32	Cotillion Gardens	Eagle Creek	20	Cl_2
23	Fern Grove Social Club	Well (horizontal)	62	none
38	Forest Hills Trailer Court	2 Wells	28	none
28	Forest Lakes Water Company	Gold Gulch, Tunnel Gulch, Scenic Creeks and a well and springs	235	F, Cl_2
7	Forest Springs Cooperative Mutual Association Water Co.	Springs	115	none

F . . . .Filtration
Cl_2 . . .Chlorination
S . . . .Softening

TABLE 1 (contd)

Identification Number	System	Source(s) of Supply	Number of Service Connections	Treatment
35	George Dufour Company	Springs	115	none
20	Glenwood Acres MWC	Well, Spring	12	none
30	Gold Gulch River Park Mutual Water Company	Spring, Well, San Lorenzo River	30	Cl_2
29	Griffen's Resort Motel	San Lorenzo River and Well	11	F, S, Iron removal, Cl_2
5	Camp Harmon	Well and San Lorenzo River	1 + Camp	Cl_2
9	Huckleberry Woods MWC	Horizontal well + Citizen's Utility Connection	35	none
21	Jud Water System	Well	3	S, Cl_2
42	Clarence King Water System	Well, Bean Creek	6	none
16	Lompico County Water Dist.	Springs, Well, Lompico Creek	300	Cl_2, F well
14	Love Creek Heights MWC	Spring	21	none
36	Manana Woods MWC	Wells	78	none
43	Mission Springs Conference Grounds	2 Wells	150	none
34	Mount Hermon Association	Springs	460	Cl_2
13	Mountain Springs Water Service	Marshall Creek	8	F
26	Olympic Circle MWC	Springs	44	none
4	Ramona Woods MWC	Springs	25	Cl_2
11	J. B. Ranch MWC	Spring	7	none
22	Camp Redwood Glen	3 Wells, Bean Creek	30	S, Cl_2

F . . . .Filtration
Cl_2 . . .Chlorination
S . . . .Softening

TABLE 1 (contd)

Identification Number	System	Source(s) of Supply	Number of Service Connections	Treatment
3	Ridgeview Estates Water	Well	7	none
27	River Grove Resort	Spring, Boulder Creek	30	F
33	Rolling Woods	Well	36	none
33	Rolling Woods MWC	Wells	53	none
24	San Lorenzo Valley County Water District	Spring, Zayante and Newell Creek	525	Cl_2
1	San Lorenzo River Park MWC	San Lorenzo River	86	Cl_2
2	San Lorenzo Woods Mutual Water Company	Spring and San Lorenzo River	51	Cl_2
15	City of Santa Cruz	Coastal Creeks and Springs, San Lorenzo River and Newell Creek	13,500	F, Cl_2
47	Santa's Village Water System	Horizontal Well and Carbonera Creek, S.V.C.W.D.	4 + Park	none
46	Scotts Valley County	Wells	304	Cl_2
45	Scotts Valley Trailer Court	Well	25	none
32	Smithwoods Resort	Well and Eagle Creek	34	none
19	Spring Brook MWC	3 Wells	7	none
39	Terrace View Water Co.	Well	15	none
31	Tollhouse Resort	Springs	10	none
40	Turchet Water Service	2 Springs	2	Cl_2
37	Wesleyan Park	2 Wells	20	none

F . . . .Filtration
Cl_2 . . .Chlorination
S . . . .Softening

Loch Lomond, as the Newell Creek reservoir is called, was completed by the city in 1961 to augment the limited coastal sources and is the only reservoir of substantial size in the watershed. It has an estimated safe annual yield of 2,500 acre-feet to the supply pipeline besides discharging 730 acre-feet per year to Newell Creek to meet the flow requirement of one cubic foot per second (cfs) for fishlife downstream. The safe annual yield is divided between the San Lorenzo County Water District, which receives 12.5 percent, and the City of Santa Cruz, which uses the remainder. Water from the reservoir flows through a pipeline by gravity to a booster pump station at Felton from where it is lifted to the Graham Hill Water Treatment Plant.

Pumpage from the San Lorenzo River intake pumping station varies with the demand for water and the full annual pumping capacity is not presently used. The city now operates the river pumping station only from May to about November during any year. In the fiscal year 1963-64, the coastal streams supplied 53 percent of the water used by the city, while Loch Lomond supplied 35 percent and the San Lorenzo River supplied 12 percent.(27)

The city delivers water to about 14,000 service connections within the city limits and several adjacent unincorporated areas. Many of these connections serve summer and weekend residences with a low winter water demand. The large influx of tourists and the seasonal operation of food processing plants combine to create a summer water demand much greater than the winter requirement. This variable demand necessitates a water treatment plant with a relatively large capacity during the summer and fall when Newell Creek and the San Lorenzo River are the main sources of supply.

Citizens Utility Company

The second largest water system in the San Lorenzo River Basin is owned and operated by the Citizens Utility Company. It supplies water to more than 3,700 customers in Boulder Creek, Felton, and adjacent areas, and also serves as an emergency supply for several small water systems. The company obtains water from springs, tributary streams of the San Lorenzo River, and a few wells in outlying areas. The manager of Citizens Utility Company stated that they have recently been forced to abandon several of their surface water sources because of excessive turbidity or other forms of degradation.

Other Water Systems

Because of the scattered development, the remaining water systems are generally small and serve single subdivisions or groups of adjacent houses. Three county water districts, San Lorenzo Valley, Scotts Valley, and Lompico, are the first attempts at consolidating some of these small water systems to provide financial and managerial responsibility so that effective service can be assured and so that systems can be improved as necessary. Ground water is the most common source of water for these supply systems, and most of them provide no treatment.

All supply systems which use the San Lorenzo River as a source chlorinate the water, but some of the systems using tributary streams deliver untreated water. Practically all these water systems are subject to wide seasonal variations in demand because of the large number of summer residences in the watershed. Several systems often experience severe water shortages during the late summer when demand is the highest. In November 1964, a sign was observed at the entrance to one subdivision warning residents that the supply was limited and not suitable for drinking.

Most of the residences located away from the developed areas have individual water systems which use springs, wells, or surface water as sources. Small, private pumps were observed in Bear, Love, Zayante, Bean, and Carbonera Creeks. Local residents stated that these pumps normally were used to supply water for gardening and that bottled or utility water was used to meet household requirements.

Recreation

Another major use of water in the study area is associated with recreation of various types. Swimming and fishing are very popular in season, and esthetic enjoyment is a year-around benefit of the river system.

Swimming and Wading

Practically every stream in the watershed supports swimming or wading during the warm weather. Temporary dams are placed across the main river at Boulder Creek and Ben Lomond during the summer to create swimming areas adjacent to public parks. The dam in the town of Boulder Creek backs the water up to the confluence of Boulder Creek and the San Lorenzo River to create a swimming area about six feet deep. A sandy beach is maintained at the water's edge, and picnic tables and dressing rooms are provided on a paved area above the beach. During the sampling trips, up to 60 people were observed using the park and swimming area, and a park caretaker stated that up to 100 people use the park on weekends.

The park at Ben Lomond provides similar facilities but receives heavier use during the tourist season. Local authorities estimate that 600-700 people often use the facilities in a day, with up to 200 swimming at one time.

Temporary dams also are placed in the main river at Camp Campbell and the San Lorenzo Woods Subdivision to create swimming areas. A resident of San Lorenzo Woods stated that the pool is also considered as a reservoir for fire protection.

At Big Trees State Park, a trail parallels the river for about two miles. The park ranger estimates that many of the 150,000 annual visitors to the park wade at numerous points along the trail.

In addition to these public recreation areas, a large number of private resorts maintain swimming areas. Many of the people, especially children, residing along the tributary creeks and the main river swim or wade in the water near their homes. Numerous places were observed where children had built rock dams to back up the water and create swimming areas.

The beach at Santa Cruz is one of the finest in Northern California and attracts thousands of visitors each year. Many of these vacationers swim in the mouth of the San Lorenzo River because of the lack of breakers and the warmer water.

Sport Fishing and Fish Propagation

The San Lorenzo River is considered to be one of the most important rivers south of San Francisco Bay for sport fishing. Approximately 200 miles of main river and tributaries are used by silver salmon, steelhead, and resident rainbow trout. A breakdown by tributaries and use by species is given in Table 2.

The steelhead is the most important fish species in the river system. Steelhead trout enter the river following the first fall rains. The run peaks in January and normally continues through March. Some years, however, the run continues as late as May. The steelhead enter almost all the tributary streams, using the upper reaches for spawning.

Silver salmon also enter the river from the sea following the first fall rains in October and November. The run peaks in January and terminates by the first of March. Silver salmon are known to utilize eight tributary streams, as well as the main river, for spawning.

Resident rainbow trout inhabit nearly all the tributary streams. They are found throughout each stream from headwaters to mouth, although they appear to be most abundant above migratory steelhead and salmon barriers.

The fishery resources of the San Lorenzo River drainage are managed for a winter and summer fishery as follows:

> The lower 12.5 miles of the San Lorenzo River from Boulder Creek Dam to the river mouth are open to winter steelhead and silver salmon angling (November 1 to February 28). The remaining portions of the system, which include the main river above Boulder Creek Dam and all tributaries, are closed to winter angling. This action is necessary to protect adult fish on the spawning grounds.
>
> The river above Boulder Creek Dam and all tributaries are open to summer trout angling (May 1 to October 31). The remaining lower 12.5 miles of the main river are closed at this time to protect yearling steelhead and silver salmon which use this area as a nursery. Studies conducted by the State Department of Fish and Game have established this closed area as being necessary to the maintenance of steelhead and silver salmon in the San Lorenzo River system.

The most recent estimate of average annual harvest of winter-caught steelhead is over 5,000, and angling pressure during the winter is estimated at over 18,000 angler days. A considerable number of fish caught each summer as trout are really juvenile steelhead. The Department of Fish and Game augments the fishable stocks of trout by planting annually 23,500 catchable size rainbow trout. Approximately 18,000 are planted in the 5-1/2 mile section of the San Lorenzo River above Boulder Creek Dam. The remaining 5,000 are stocked in Fall Creek.

TABLE 2

STREAMS UTILIZED BY SALMONOIDS
IN THE SAN LORENZO RIVER SYSTEM
SANTA CRUZ COUNTY

Stream	Stream Miles Utilized by Fishes		
	Resident Rainbow Trout	Steelhead Trout	Silver Salmon
Main River	1	30	25
Branciforte Creek	7	6	10
Carbonera Creek	9	4	4
Powder Mill Creek	2	-	-
Eagle Creek	1	1	-
Zayante Creek	14	8	8
Bean Creek	9	6	6
Lompico Creek	4	-	-
East Branch Zayante	3	2	2
Fall Creek	4	3	3
Newell Creek	5	3	3
Marshall Creek	1	1	-
Love Creek	5	3	3
Clear Creek	2	-	-
Bear Creek	9	9	6
Deer Creek	3	3	3
Boulder Creek	7	5	3
Jamison Creek	2	1	0
Hare Creek	3	1	-
Two Bar Creek	4	4	1
Kings Creek	6	6	6
Unnamed Tributaries	10	10	-
Total	111	106	83

Loch Lomond is open to both rowboat and shore fishing. Facilities for picnicking, parking, and boat launching have been provided by the City of Santa Cruz with state assistance under the Davis-Grunsky Act.

Boating

The entire stream system in the San Lorenzo watershed is too small to support power boat operation. Small, hand-powered boats can be used in some of the larger pools created by the tributary streams. A boat rental business exists near the mouth of the river for small manually powered boats. Row boats presently are allowed on Loch Lomond for sport fishing, but the City of Santa Cruz does not plan to open the reservoir to motor boats.

Esthetic Enjoyment

The San Lorenzo River and its tributary streams are pleasant to view from practically every point in the watershed. The large influx of sightseers throughout the summer and the large number of residences built close to the water are testimony to this fact. Many of the resorts depend on the crystal clear water to draw customers. Brookdale Lodge in Brookdale has Clear Creek, a tributary to the main river, running through its dining room. Any impairment, such as excessive turbidity, color, or odor, in these streams would have an adverse effect on the economy of the area.

Some of the areas of the San Lorenzo Valley have well-kept riding trails that cross or pass close to the creeks and river. Numerous undeveloped paths and trails were observed along those creeks which were inspected by wading.

Industrial Use

Industrial water use in the lower San Lorenzo River watershed generally occurs only in and around the City of Santa Cruz. The Pasatiempo Golf Course, several food processing plants, and a tannery are the major water users, and all obtain their water from the city's system.

Sand washing by the aggregate industry constitutes the only major industrial water use in the upper watershed. There are four aggregate processing plants along Zayante and Bean Creeks, and one other is located in Scotts Valley. One of these plants obtains water from Bean Creek, while the other four use ground water. Two of these ground water using plants have holding ponds which allow their used wash water to percolate into the ground for reuse.

Some logging, two sawmills, and an asphaltic pavement plant make up the remaining heavy industry, but none of these is a large water user.

Agricultural Use

The steep and heavily wooded hillsides in most of the watershed and residential or recreational use of other lands leave very little land area available for agriculture. Consequently, little water is used for irrigation. Scotts Valley and some areas along Branciforte Creek support small vineyards or orchards and some cattle. Water for these areas is normally obtained from wells. The San Lorenzo Valley supports practically no farming, since the narrow valley floor is essentially covered with residences and resorts. Some cattle grazing is found along the upper reaches of Kings and Bear Creeks.

Waste Transport

Many of the tributary streams of the San Lorenzo River also are used inadvertently or, in some instances, deliberately for waste transport. There is no sewage collection or treatment system in the entire drainage area except for several scattered subdivisions and for the City of Santa Cruz. Bear Creek Estates is partially served by a collection and treatment system which disposes of intensively-treated effluent by spraying on a wooded hillside. Big Basin Woods Subdivision provides extended aeration treatment and percolation disposal, while Boulder Creek Country Club Estates collects the leachings from individual septic tanks for percolation disposal. Rolling Woods Subdivision also disposes of treated effluent by percolation. The requirements adopted by the Central Coastal Regional Water Quality Control Board for these discharges are found in Appendix B.

The great majority of the residences in the study area use individual septic tanks and leaching fields. The relatively impermeable soils in much of the valley area cause septic tank effluents to rise to the surface. This rising water often creates swampy areas which drain overland to the nearest stream. Both Boulder Creek and Felton are currently experiencing surface leaching in areas adjacent to their business districts. Seepage was observed to several creeks during the field investigations by both Department of Water Resources and Santa Cruz County Health Department personnel. Corrective measures have been taken in those cases where septic tank failures were the cause.

Besides inadvertent entrance of waste water to some of the streams, evidence of direct sewage discharge into Love Creek was observed. Home laundry waste is discharged to several of the creeks by adjacent residences.

There are also some industrial wastes discharged to the river system. The Santa Cruz Dairy in Scotts Valley discharges its barn waste water to Carbonera Creek by overland flow. The two sand washing plants which discharge their wash water to Zayante and Bean Creeks have caused a silting problem in the creekbeds. Both of these plants have made recent attempts to eliminate this problem.

Proposed Water Developments

In recent years, there has been a growing interest in developing supplemental water from within the drainage basin to serve the San Lorenzo Valley and the City of Santa Cruz. Bulletin No. 5 of the State Water Resources Board, "Santa Cruz-Monterey Counties Investigation", reported studies of seven alternative projects in 1953 and concluded that a dam and reservoir on Zayante Creek would be the most feasible. The dam was proposed to be located in Section 36, Township 9 South, Range 2 West, MDB and M. Bulletin No. 3 of the Department of Water Resources, "The California Water Plan", proposed the Zayante Project along with another dam on Bear Creek between Sections 9 and 10, Township 9 South, Range 2 West, MDB and M in 1952. In 1963, Brown and Caldwell, consulting engineers, studied the water supply and distribution system of Santa Cruz and also recommended the Bear Creek and Zayante Creek Projects.

A dam and reservoir on the mainstem of the river at Waterman Switch were mentioned in both Bulletin No. 5 and the Brown and Caldwell report, but their usefulness was considered to be limited to the northern part of the San Lorenzo Valley. Continued residential development in this area may make this project economically feasible in the future. Plate 1 shows the locations of these three proposed dams.

Any new reservoirs in the watershed probably would alter the present pattern of water use. The relatively large bodies of water created would result in a demand for more boating and swimming facilities. Unless special provisions were made, construction of dams would alter the fishery by blocking passage to upstream spawning areas. However, additional reservoirs in the watershed possibly could provide enough storage to begin a program of low flow augmentation. Such a program consists of conserving the winter runoff for release during periods of low flow to sustain fish life and to provide dilution for the pollutants or degradants which are always present to some degree.

It is also very likely that further residential and tourist development would be stimulated by providing a greater streamflow of high quality water in the river during the critical summer months. Additional industry might be attracted to the area if a stable water supply of suitable quality were developed by the construction of these proposed projects. Irrigation demands are not apt to change appreciably.

CHAPTER III. GEOLOGY AND HYDROLOGY

Some knowledge of the geology and hydrology of a watershed is essential to a thorough evaluation of water quality. The geology of an area greatly affects the mineral content of both surface and ground water and largely determines where ground water will be found. In the San Lorenzo River watershed, the pattern of precipitation and runoff essentially determines the local hydrology, which, together with the areal geology, can serve as the basis for predictions of water quality.

Geology

The generally mountainous and rugged topography of the San Lorenzo River drainage basin is predominantly due to a structural uplift running northwest and southeast and to differential erosion by the river and its tributaries. A series of anticlines and synclines (arches and dips) in the stratified rock, which have been mapped in the northern portion of the drainage basin, illustrate the folded nature of the area. Major faults are the Butano, Zayante, Ben Lomond, and Kings Creek faults (Plate 3).

Geologic formations are subdivided for this study into two divisions based on their water-bearing characteristics. The two divisions are the relatively impermeable (nonwater-bearing) formations and the permeable (water-bearing) formations. Nonwater-bearing formations include Mesozoic granitic rocks and Tertiary consolidated sedimentary rocks of the Butano, San Lorenzo, Vaqueros, Sandholt, and Monterey Formations. Water-bearing formations include unconsolidated or semiconsolidated Tertiary (Miocene) sediments of the Santa Margarita Formation, and Quaternary terrace deposits and alluvium.

Nonwater-Bearing Formations

Mesozoic granitic rocks, chiefly quartz diorite and gabbro, are exposed on Ben Lomond Mountain on the west side of the drainage basin. Streams tributary to the San Lorenzo River which drain this area include Fall, Marshall, Alba, and Clear Creek and tributaries of Boulder Creek. The granitic rocks also occur as outcrops along the middle reach of Carbonera Creek and along the San Lorenzo River below Big Trees.

The Butano, San Lorenzo, Vaqueros, Sandholt, and Monterey formations are consolidated sediments composed principally of marine sandstones and shales that have been folded and faulted. Boulder Creek, the upper reaches of the San Lorenzo River, and the east side tributaries (Kings, Two Bar, Bear, Love, Newell, Lompico, and Zayante Creeks) drain areas underlain by these rocks.

Water-Bearing Formations

The Santa Margarita Formation consists of medium to coarse-grained unconsolidated to consolidated quartz sand. It overlies the older nonwater-bearing units, underlies the younger partially water-bearing Purisima Formation, and is exposed discontinuously in a triangular area between Ben Lomond and Santa Cruz. The Santa Margarita Formation, unusually uniform in grain size is used extensively by the aggregate industry. Zayante, Bean, and Carbonera Creeks flow over deposits of this formation and in many places have eroded through it, exposing the older relatively impermeable rocks. Most wells drawing water from the Santa Margarita Formation produce small amounts of water and are used for domestic supply; however, a few wells with moderate capacity also exist.

The Purisima Formation which overlies the Santa Margarita Formation consists essentially of shale and fine to coarse-grained sandstone.

It is partly continental and partly marine in origin. In this report, only the continental deposits are considered to be water-bearing because they appear to be much more permeable than the marine deposits. Exposures of the Purisima Formation occur to the northeast of Santa Cruz, and Branciforte and Granite Creeks drain areas underlain principally by Purisima deposits. Only small, domestic wells draw water from the Purisima Formation in this drainage basin, although these sediments are reported to yield substantial quantities of water to irrigation wells in nearby Soquel Valley.

Quaternary terrace deposits are of two origins, marine and continental. Marine terraces of different elevations occur near the coast in the vicinity of Santa Cruz and reflect a series of historical changes of sea level with respect to land surface. Uplifted continental terrace deposits occur along the San Lorenzo River from Riverside Grove to Felton. They average about 15 to 20 feet thick and overlie exposed nonwater-bearing consolidated sedimentary rocks approximately 5 to 15 feet above San Lorenzo River and several of its tributaries. Both the marine and continental deposits are thin and commonly contain gravel, sand, and silt. They are able to store only limited quantities of ground water due to their small areal extent, limited thickness, and lack of hydrologic barriers adjacent to streams and the ocean.

The most extensive areas of Quaternary alluvium occur in Scotts Valley; along Zayante, Branciforte, and Bean Creeks; and along the San Lorenzo River at Santa Cruz. The ground water reservoirs formed by these alluvial deposits are mostly thin and are composed of layers of sand, gravel, silt, and clay.

Ground Water Hydrology

In the San Lorenzo River drainage basin, ground water generally is unconfined in the Santa Margarita Formation. The limited quantities of water in the Purisima Formation probably exist both confined and unconfined. Recharge to these formations is primarily from infiltration of rainfall in areas of high permeability. The infiltrating water moves down to the water table and then laterally from topographically higher areas toward areas of lower surface elevations, where it is discharged on the surface in springs or moves into the adjacent, more permeable, alluvium. Water of excellent mineral quality is found in the Santa Margarita Formation. This is due to the low solubility of the quartz grains which make up the formation. Although data are sparse, good quality water is also believed to occur in some of the permeable deposits of the Purisima Formation. Ground water quality is discussed in more detail in Chapter IV.

Ground water occurs unconfined in the terrace deposits. These water-bearing units are recharged by infiltration of rainfall and by influent seepage of surface runoff from adjacent, topographically higher, less permeable formations. Ground water moves in the stream terraces toward the San Lorenzo River and in the marine terraces toward the ocean. The ground water often discharges at the exposed bases of these deposits.

Ground water in the alluvium is also largely unconfined; and ground water reservoirs along Zayante, Bean, Branciforte, and Carbonera Creeks and along the San Lorenzo River are recharged predominantly by influent seepage from surface streams and by subsurface movement of ground water from the adjacent Santa Margarita Formation and portions of the Purisima Formation. Ground water moves toward the center of the valleys and then downstream. Discharge from these alluvial basins is by effluent seepage into streams, evapotranspiration, and extraction of ground water from wells.

Many domestic wells draw limited amounts of ground water from decomposed granitic and older consolidated sedimentary rocks, which are considered to be essentially nonwater-bearing. The water probably moves principally through cracks, fissures, and other secondary openings. Quality data are lacking on ground water from the consolidated sedimentary rocks of marine origin within the area of investigation, but analyses from adjacent areas indicate these rocks probably contain poor quality water.

Precipitation

The San Lorenzo River watershed area has large seasonal variations in precipitation. At Boulder Creek, recorded extremes of annual precipitation are a low 20 inches and a high of 123 inches. Table 3 shows annual precipitation means and extremes for three stations with long periods of record.

At the Santa Cruz station, with 72 years of record, the average annual rainfall is 28.65 inches. Ben Lomond has an average annual precipitation of about 55 inches for a 43-year period, and Boulder Creek has averaged about 56 inches per year over a 47-year broken record. These figures show that the upper San Lorenzo Valley receives considerably more precipitation than the coastal area at Santa Cruz.

TABLE 3

MEAN, MAXIMUM, AND MINIMUM ANNUAL PRECIPITATION
AT BEN LOMOND, BOULDER CREEK, AND SANTA CRUZ

	Ben Lomond	Boulder Creek	Santa Cruz
Station Elevation (feet)	500	470	20
Source of Record	USWB	USWB*	USWB
Length of Rainfall Record (years)	43	47**	72
Mean Seasonal Precipitation (inches)	54.96	56.17	28.65
Maximum Seasonal Precipitation (inches)	100.18	123.65	61.62
(year)	1940-41	1889-90	1940-41
Minimum Seasonal Precipitation (inches)	27.67	20.15	10.85
(year)	1938-39	1923-24	1923-24

* Cooperative observer.
** Broken record.

Nearly 90 percent of the mean annual precipitation in the Santa Cruz area occurs during the six months from November through April. Generally, only traces of rain fall intermittently during the summer months. Table 4 gives the mean monthly distribution of precipitation as recorded at the Santa Cruz station.

TABLE 4

MEAN MONTHLY DISTRIBUTION OF PRECIPITATION
AT SANTA CRUZ

Month	Precipitation in inches	Percent of Annual Total	Month	Precipitation in inches	Percent of Annual Total
July	0.03	0.1	January	5.80	20.6
August	0.03	0.1	February	5.24	18.6
September	0.49	1.7	March	4.12	14.6
October	1.41	5.0	April	1.87	6.6
November	2.69	9.5	May	0.98	3.5
December	5.35	18.9	June	0.23	0.8

Runoff

Three stream gaging stations are presently operated on the San Lorenzo River system by the United States Geological Survey (U.S.G.S.). The longest record is provided by the water stage recorder on the San Lorenzo River at Big Trees, which has a continuous record from 1937 to the present. Table 5 lists the stream gaging stations in the study area together with their drainage areas, length of records, and average annual flows.

TABLE 5

AVERAGE RECORDED FLOWS
AT ZAYANTE CREEK, SAN LORENZO RIVER, AND BRANCIFORTE CREEK
STREAM GAGING STATIONS

	Drainage Area, in Square Miles	Period of Record	Average Annual Flow in Acre-Feet/Year
Zayante Creek Zayante, Calif.	11.1	1957-63	7,670
San Lorenzo River Big Trees, Calif.	111	1936-63	99,180
Branciforte Creek Santa Cruz, Calif.	17.3	1940-43 1952-63	15,570

The runoff pattern for the watershed reflects the wet winters and dry summers of the area. Nearly 90 percent of the annual runoff occurs in the six months from December through May. Table 6 presents the mean monthly distribution of runoff as recorded at Big Trees.

TABLE 6

MONTHLY DISTRIBUTION OF ANNUAL RUNOFF,
SAN LORENZO RIVER AT BIG TREES
27-year average (1936-37 to 1962-63)

Month	Runoff (Acre-Feet)	Percent of Annual Runoff
October	1,630	1.7
November	2,810	2.9
December	11,150	11.5
January	17,230	17.7
February	23,000	23.6
March	18,040	18.5
April	11,800	12.2
May	4,720	4.9
June	2,600	2.7
July	1,720	1.8
August	1,280	1.3
September	1,160	1.2

During the rainy season, the San Lorenzo River system can generally be considered to exhibit unregulated flow. The rapid rise and decline of the river stage during and following a storm is characteristic of watersheds with relatively small drainage areas and few works to retard the flow.

The only significant storage reservoir in the watershed is formed by a dam on Newell Creek completed by the City of Santa Cruz in 1961. During the summer, temporary dams are placed on the San Lorenzo River at Boulder Creek and Ben Lomond to create swimming areas adjacent to recreation parks. However, neither of these structures affects winter runoff because they are removed at the end of the summer.

There is no import or export of water from the valley area, but the City of Santa Cruz diverts substantial quantities of water at Newell Creek and from the San Lorenzo River at Santa Cruz for water supply. In addition, numerous smaller diversions exist for water supply by utility companies and private individuals in the watershed area. These diversions are not large enough to alter the pattern of storm runoff, but the heavy summer use noticeably decreases the dry-weather flows, particularly on some of the smaller tributaries.

Table 7 represents an attempt to establish a correlation between the flows of each of the major tributary streams above the Big Trees station and the flow of the main river at Big Trees. Throughout the field investigation, the instantaneous flow of each of the streams was estimated as the monthly sample was collected. These estimates were then adjusted to conform to the measured flow at the gauging stations and were also checked by salt-dilution techniques. Table 7 lists the major tributary streams of the upper San Lorenzo River in downstream order along with the drainage area of each stream and its estimated percentage contribution to the dry-weather flow at Big Trees. These estimates probably are accurate within a range of ± 50 percent.

Information presented in Table 7 shows that there is no directly proportional relationship between the drainage areas and the flows of the major tributaries in the upper watershed. This is primarily due to variations in topography, geology, vegetative cover, and the areal precipitation pattern. As the result of a combination of these factors, the west side of the San Lorenzo Valley is generally more moist and has many more springs than the east side. Also, the west side springs have a fairly

TABLE 7

UPPER SAN LORENZO RIVER BASIN
ESTIMATED DRY-WEATHER FLOW DISTRIBUTION

	Drainage Area, in Square Miles	Percent of Flow at Big Trees*
San Lorenzo River at Waterman Switch	5.9	4
Kings Creek at Redwood Grove, Calif.	7.9	2
Two Bar Creek near Boulder Creek, Calif.	2.5	1
Bear Creek at Boulder Creek, Calif.	16.3	10
Boulder Creek at Boulder Creek, Calif.	11.6	20
Clear Creek at Brookdale, Calif.	1.6	4
Alba Creek	0.5	1
Marshall Creek	1.2	2
Love Creek at Ben Lomond, Calif.	3.0	1
Newell Creek at Ben Lomond, Calif.	-	5**
Fall Creek at Felton, Calif.	4.9	8
Zayante Creek at Felton, Calif.	26.4	32
Other accretions		10
TOTAL		100

* Based on a flow of 20 to 30 cubic feet per second (cfs) at Big Trees.
** A minimum flow of one cfs must be maintained in Newell Creek by releases from Loch Lomond.

steady year-around flow, whereas the east side springs show a greater tendency to dry up in the late summer and early fall. Thus, the west side streams yield a larger dry-weather flow per square mile of drainage area than the east side streams.

CHAPTER IV. QUALITY OF WATER

Quality of water is as important as quantity. An abundant supply of water is of little value unless it is of satisfactory quality (or can be economically treated to make it suitable) for one or more beneficial uses.

Chemical Characteristics of Natural Waters

All natural waters in or on the ground contain dissolved minerals. Even raindrops while falling absorb minor amounts of chemicals, chiefly carbon dioxide, from the atmosphere. Water containing carbon dioxide derived from the atmosphere and organic acids from the soil dissolves minerals in soil and rock formations. Consequently, the chemical characteristics of surface and ground waters in any particular area are related to the composition of soils and rock formations in that area.

The mineral constituents in solution in water exist in ionized form as positive ions (cations) and negative ions (anions). In natural waters, the most prevalent cations are calcium, magnesium, and sodium; and the most prevalent anions are bicarbonate, sulfate, and chloride. Waters are classified, with respect to mineral composition, in terms of the predominant (greater than 50%) ions, expressed in equivalent weights. Where no one ion fulfills the requirement, a hyphenated combination of the two most abundant constituents is used. Thus, in a calcium bicarbonate type water, calcium constitutes at least half the cations and bicarbonate represents at least half the anions. Where calcium, though predominant, is less than half, and sodium is next in abundance, the name is modified to calcium-sodium bicarbonate.

As the character or type of mineral pickup by a water is governed by the rock formation through which it flows, so also is the quantity of mineral pickup. However, in addition to the kind of formation through which a water flows, the length of time the water is in contact with the soil or rock formation has a great effect on the quantity of minerals that go into solution. Thus, barring man-made pollution, the mineral quality of a stream is related to the distance of the water from its source, the area of contact with the rock formation, as well as the kind of formation, and the flow characteristics (velocity, turbulence, etc.). Most streams in California improve in quality with higher flows in the winter and spring and deteriorate in quality with lower flows in the summer and fall.

Water Quality Criteria

The average water user judges water quality by clarity, palatability, and freedom from objectionable taste or odor. These requirements are subjective and are not based on chemical or biologic considerations. However, in all activities dealing with objective observation and measurement of scientific data, there must be standards by which the observer, planner, or user can judge or classify the information gathered. With regard to water quality, the problem is to determine whether or not water is suitable for the anticipated use or uses.

Criteria presented in the following sections can be used to evaluate water quality relative to the broad categories of beneficial uses indicated. These criteria are merely guides to the appraisal of water quality. Except for those constituents which are considered toxic to human beings, these criteria are suggested, rather than mandatory, limiting values. Water in which one or more of the limiting values are exceeded need not be eliminated from consideration as a source of supply, but other sources of better quality water should be investigated.

Criteria for Drinking Water

Criteria for evaluating the suitability of water for domestic and municipal use in connection with interstate quarantine have been promulgated by the United States Public Health Service. The limiting concentrations of chemical substances and radioactivity in drinking water have been abstracted from these criteria and are shown in Tables 8 and 9, respectively. Organic, bacteriological, or other chemical substances may be limited if their presence renders the water hazardous for use.

TABLE 8

UNITED STATES PUBLIC HEALTH SERVICE
DRINKING WATER STANDARDS
1962

Chemical Substance	Recommended Limit, in ppm	Mandatory Limit, in ppm
Alkyl benzene sulfonate (detergent)	0.5	
Arsenic (As)	0.01	0.05
Barium (Ba)		1.0
Cadmium (Cd)		0.01
Carbon chloroform extract	0.2	
Chloride (Cl)	250	
Hexavelent chromium (Cr^{+6})		0.05
Copper (Cu)	1.0	
Cyanide (Cn)	0.01	0.2
Fluoride (F) (See Table 11)		
Iron (Fe)	0.3	
Lead (Pb)		0.05
Manganese (Mn)	0.05	
Nitrate (NO_3)	45	
Phenols	0.001	
Selenium (Se)		0.01
Silver (Ag)		0.05
Sulfate (SO_4)	250	
Total dissolved solids (TDS)	500	
Zinc (Zn)	5	

TABLE 9

ALLOWABLE CONCENTRATIONS OF RADIOACTIVITY IN DRINKING WATER

Constituent	Recommended Maximum Limits, in micromicrocuries per liter
Radium ^{226}	3
Strontium ^{90}	10
Gross beta activity	1,000*

* In the known absence of strontium 90 and alpha emitters.

Drinking water should not contain impurities which would offend the sense of sight, taste, or smell. The United States Public Health Service has suggested the following limits for physical characteristics.

TABLE 10

PHYSICAL CHARACTERISTICS IN DRINKING WATER

Characteristic	Recommended Limit
Turbidity, units	5
Color, units	15
Threshold odor number	3

When fluoride is naturally present in drinking water, the concentration should not average more than the appropriate upper limit in Table 11. Presence of fluoride in average concentrations greater than two times the optimum values in the tabulation shall constitute grounds for rejection of the supply.

TABLE 11

FLUORIDE-TEMPERATURE RELATIONSHIPS
(U. S. PUBLIC HEALTH SERVICE)

Annual average of maximum daily air temperatures*	Recommended control limits -- Fluoride concentration in ppm		
	Lower	Optimum	Upper
50.0-53.7	0.9	1.2	1.7
53.8-58.3	0.8	1.1	1.5
58.4-63.8	0.8	1.0	1.3
63.9-70.6	0.7	0.9	1.2
70.7-79.2	0.7	0.8	1.0
79.3-90.5	0.6	0.7	0.8

* Based on temperature data obtained for a minimum of 5 years.

The California State Board of Public Health also has defined the maximum safe amounts of fluoride ion in drinking water in relation to mean annual temperature. These relationships are shown in Table 12.

TABLE 12

FLUORIDE-TEMPERATURE RELATIONSHIPS
(CALIFORNIA STATE BOARD OF PUBLIC HEALTH)

Mean annual temperature	Mean monthly fluoride ion concentration
50°F	1.5 ppm
60°F	1.0 ppm
70° F and above	0.7 ppm

Interim standards for certain mineral constituents have been adopted by the California State Board of Public Health. Based on these standards, temporary permits may be issued for drinking water supplies failing to meet the United States Public Health Service Drinking Water Standards, provided the mineral concentrations in Table 13 are not exceeded.

TABLE 13

INTERIM UPPER LIMITS OF TOTAL SOLIDS AND SELECTED MINERALS, CALIFORNIA STATE BOARD OF PUBLIC HEALTH

Constituent	Permit, in ppm	Temporary Permit, in ppm
Total solids	500 (1000)*	1500
Sulfates (SO_4)	250 (500)*	600
Chlorides (Cl)	250 (500)*	600
Magnesium (Mg)	125 (125)	150

* Numbers in parentheses are maximum permissible, to be used only where no other more suitable water is available in sufficient quantity for use in the system.

Criteria for Irrigation Water

Criteria for mineral quality of irrigation water have been developed by the Regional Salinity Laboratories of the United States Department of Agriculture in cooperation with the University of California. Because of diverse climatological conditions and the variation in crops and soils in California, only general limits of quality for irrigation water can be suggested. The Department uses the following three broad classifications for irrigation water:

Class 1 - Regarded as safe and suitable for most plants under most conditions of soil and climate.

Class 2 - Regarded as possibly harmful for certain crops under certain conditions of soil or climate, particularly in the higher ranges of this class.

Class 3 - Regarded as probably harmful to most crops and unsatisfactory for all but the most tolerant.

Limiting concentrations of chemical constituents in irrigation water as classified above are shown in Table 14.

TABLE 14

QUALITATIVE CLASSIFICATION OF IRRIGATION WATER

Chemical properties	Class 1 Excellent to good	Class 2 Good to injurious	Class 3 Injurious to unsatisfactory
Total dissolved solids, in ppm	Less than 700	700 - 2000	More than 2000
Conductance, in micromhos at 25° C	Less than 1000	1000 - 3000	More than 3000
Chlorides, in ppm	Less than 175	175 - 350	More than 350
Sodium, in percent of base constituents	Less than 60	60 - 75	More than 75
Boron, in ppm	Less than 0.5	0.5 - 2.0	More than 2.0

These criteria have limitations in actual practice. In many instances, water of a given quality may be wholly unsuitable for irrigation under certain conditions of use and yet be completely satisfactory under other circumstances. Soil permeability, drainage, temperature, humidity, rainfall, and other conditions can alter the response of a crop to a particular quality of water.

Criteria for Industrial Uses

Water quality criteria for industrial water are as varied and diversified as industry itself. Food processing, beverage production, pulp and paper manufacturing, and textile industries have exacting requirements, while cooling or metallurgical operations permit the use of poor quality water. In general, where a water supply meets drinking water standards, it is satisfactory for industrial use, either directly or following a limited amount of polishing treatment by the industry.

Hardness

Even though hardness in water is not included in the foregoing criteria, it is important in domestic and industrial uses. Excessive hardness in water used for domestic purposes causes increased consumption of soap and formation of scale in pipe and fixtures. The values for degrees of hardness in Table 15 are those suggested by the Department.

TABLE 15

HARDNESS CLASSIFICATION

Range of hardness, expressed as $CaCO_3$ (ppm)	Relative classification
0 - 100	Soft
101 - 200	Moderately hard
Greater than 200	Very hard

Preservation and Protection of Fish and Wildlife

A healthy and diversified aquatic population indicates good water quality, which in turn permits optimum beneficial uses of the water. For such a population to exist, the environment must be suitable for both the fish and the food chain organisms.

Many mineral and organic substances in low concentrations are harmful to fish and aquatic life. Insecticides, herbicides, ether soluble materials, and salts of heavy metals are of particular concern.

Tolerances to temperature extremes vary widely between fish species. In general, cold water fish are found in waters of from 32° to 65° Fahrenheit. The maximum temperature for successful salmon spawning is 58° Fahrenheit. Rapid changes in water temperature may result in fish kills.

The minimum requirements for dissolved oxygen concentration vary with the location and season. In general, 5 ppm is satisfactory for migrating fish. However, anadromous fish require at least 7 ppm dissolved oxygen in spawning areas and, under some conditions, 9 ppm.

It has been found that pH limits of 6.5 to 8.5 provide satisfactory protection for fish.

The combined effect of any chemical or physical characteristics is not the simple sum of the specific effects. For example, while the hardness of the water does not of itself affect the fish, some insecticides are more toxic in soft water and others are more toxic in hard water. These problems of synergistic and antagonistic effects extend through a wide range of materials and conditions. Frequently, determination of the effects of a particular waste discharge depends on biological studies in similar waters receiving similar wastes. In many cases, these requirements for similarity may not be met and laboratory bioassays are necessary.

Silt pollution and high turbidity damage trout and salmon resources. Silt smothers important food chain organisms and fish eggs. Excessive silt deposition can alter and destroy spawning beds, riffle areas and deep shelter pools. In many serious cases, the problem is not obvious to the casual observer.

The minimum requirements placed on discharges concerning silt and turbidity have essentially been:

1. The discharge of sewage or industrial wastes, including agricultural waste, shall not increase the turbidity of the receiving waters by more than ten percent of the turbidity value of the receiving waters immediately above the point of discharge.

2. Industrial or agricultural operations shall be conducted in such a manner that soil or any solid debris is not placed in or adjacent to streams where it will be subject to erosion by the receiving waters or runoff waters flowing into the stream.

Bacteriological Criteria

Bacteriological examinations of domestic water, by estimating bacterial density, is considered to be of significant value in apprais- ing sanitary water quality. Although not pathogenic or disease-producing in itself, the coliform group of bacteria is invariably found in large numbers in soil and in the feces of man and warm blooded animals. The specific disease-producing organisms present in water are not easily identified, and the techniques for comprehensive bacteriological examination are complex and time consuming. For these reasons, coliform concentrations are widely used as an index of bacteriological quality of water.

The drinking water bacteriological standards of the United States Public Health Service are based on limits for the mean concentration of coliform bacteria in a series of water samples and the frequency at which concentrations may exceed the mean. Results are expressed as the "most probable number" (MPN) of coliform bacteria per 100 milliliters (ml) of sample. The recommended standards for domestic water delivered to the consumer are roughly equivalent to restricting the coliform concentration to not more than one organism for each 100 ml of water[3].

For fresh-water bathing and other water-contact sports, a coliform count of 1,000 MPN per 100 ml is used as a standard in several states and has been proposed as a recommended limit in California. This figure has been used as an ocean-water contact-sports standard for a number of years.

Present Surface Water Quality

Present mineral quality of surface water in the San Lorenzo River watershed was determined by monthly grab samples from several reaches of the main stem and all the major tributaries of the river from September 1963 to October 1964. Bacteriological quality (coliform densities) was evaluated by the Santa Cruz County Health Department based on samples collected during the summer of 1964. Locations of water quality sampling points are shown on Plate 4, and chemical analyses of surface waters are listed in Appendix C.

As mentioned in the introduction, the upper reach of the San Lorenzo River is of poorer mineral quality than the San Lorenzo River at the check dam near its mouth, where it is diverted for municipal use by the City of Santa Cruz. Also, three major tributaries are of poorer quality in their upper reaches than at their confluence with the main stem. These phenomena are depicted graphically on Plates 5 and 6. Plate 5 shows that water of the San Lorenzo River is only slightly more than half as mineralized at the check dam near the mouth as in its upper reach near Waterman Switch. This can be explained by the excellent quality water flowing from the slopes of Ben Lomond Mountain. Water from such spring-fed tributaries as Boulder Creek, Alba Creek, Clear Creek, Marshall Creek, and Fall Creek are only about one-third as mineralized as the water in the upper main stem near Waterman Switch. This excellent quality water mixed with the more highly mineralized water from the east side streams, which is generally equivalent to the water in the upper main stem, results in an intermediate but still good quality water in the lower reach of the main stem at the check dam.

These differences in quality can be correlated to some extent with the geologic formations through which the water flows. Water from the west side generally flows over the hard granitic formation of Ben Lomond Mountain. The upper main stem and the east side tributaries generally flow across the more soluble terrace deposits and consolidated sedimentary rocks.

The three major tributaries, which are of somewhat better quality near their mouth than in their upstream reaches, are Boulder Creek, Bear Creek, and Zayante Creek. Boulder Creek rises in sedimentary rocks and terrace deposits, which give its upper reaches a quality similar to that of the east side streams. However, by the time it reaches the main stem, by far the larger portion of its flow has originated from the spring-fed streams rising on the slope of Ben Lomond Mountain.

Bear Creek flows across several different rock types, primarily sandstones and sediments. Hopkins Gulch, a small tributary entering Bear Creek from the north, apparently flows over a more resistant formation, since the quality of its water is somewhat better than that of the upper reaches of Bear Creek. This, together with other possible accretions, such as influent ground water or springs, makes the water of Bear Creek slightly less mineralized near its mouth than in its upstream reaches.

As can be seen graphically on Plate 5, the improvement in quality of Zayante Creek in its downstream reaches is due almost entirely to the addition of better quality and less mineralized water from its major tributary, Bean Creek. The upper reaches of Bean Creek flow over the relatively insoluble Santa Margarita Formation, resulting in less solution and pickup of minerals than in the upper reaches of Zayante Creek, which flows across undifferentiated consolidated sediments and recent alluvium. Possibly a factor of equal importance in the improvement of quality in the lower reach of Zayante Creek is the presence of several excellent quality springs which discharge to Azalea Dell Creek and to the lower reaches of Bean Creek.

Physical and Chemical Characteristics

The following paragraphs discuss significant physical and chemical characteristics of the San Lorenzo River and its tributaries.

Temperature. Water temperatures affect such physical features as density, surface tension, viscosity, and saturation values of solids and gasses, and control the rates of chemical and biochemical reactions. Temperature of water is fundamentally important in fish migration and spawning, seed germination and plant growth, and industrial cooling applications.

Year-around temperatures of surface water in the San Lorenzo River system which were encountered at the time the grab samples were taken ranged from 35° to 76° Fahrenheit. This is generally in the range of tolerance for cold-water fish. No significant variations in temperature between upstream and downstream reaches of the river system were noted.

Hydrogen-ion Concentration (pH). Most natural waters are slightly alkaline, and the San Lorenzo River is typical in this respect, with pH values ranging from 6.8 to 8.7. Tributary streams are similar, but a wider range was noted in samples from Loch Lomond, which ranged from 6.0 to 9.0. However, median values in the entire river system fall well within the pH limits of 6.5 to 8.5 which have been found satisfactory for fish.

Dissolved Oxygen. An adequate level of dissolved oxygen contributes to the palatability of a domestic water supply and assists in the stabilization of organic material, with the result that a stream is pleasing to look at, sustains desirable fish and aquatic life, and promotes recreational activities.

Concentrations of dissolved oxygen were determined monthly and, with the exception of one station, values of all stream samples ranged from 7.6 ppm to 15.0 ppm. The one exception was Station No. 10 on the upper reach of Boulder Creek where, during periods of very low flow, dissolved oxygen concentrations as low as 3.7 ppm were encountered. Although nighttime values for dissolved oxygen were not determined, the entire river system generally contains more than 5 ppm dissolved oxygen, which is considered the lower limit for migrating fish.

As is often the case with new reservoirs, a problem of insufficient dissolved oxygen has been encountered in Loch Lomond. Although concentrations are generally adequate near the surface, below the thermocline, concentrations of dissolved oxygen often approach zero.

<u>Suspended Solids, Turbidity, and Color</u>. Tests showed that suspended solids, turbidity, and color of natural streamflow on occasion exceeded the United States Public Health Service recommended limits for drinking water. Color ranged from 0 to 35 units, suspended solids ranged from 0.8 to 1440 ppm, and monthly samples from the station at Big Trees since 1951 ranged from 0.6 to 2400 turbidity units. The limited data on the tributary streams indicated that the west side tributaries are generally clear while the east side tributaries, notably Bean Creek and Zayante Creek, yield most of the suspended solids and turbidity. The high concentration of 1440 ppm of suspended solids resulted from the sample from Bean Creek on November 6, 1963. This greater silt load carried by the east side streams is readily confirmed by visual observation during periods of high flows. Bottom deposits of silt and sand are especially noticeable in the lower reaches of the main stem of San

Lorenzo River as well as in the lower reaches of Zayante and Bean Creeks.

Total Dissolved Solids and Specific Conductance. Concentrations of total dissolved solids may be determined by weighing the residue on evaporation or by summation of the concentrations of individual constituents. The electrical conductivity of water is directly proportional to the amount of dissolved minerals and can be measured continuously. This is reported as specific conductance in micromhos. In surface water of the San Lorenzo River watershed, concentration of total dissolved solids in ppm is about 0.6 of the specific conductance in micromhos.

A continuous conductivity recorder was operated on San Lorenzo River at the check dam from the first part of July through October of 1964. During this period, specific conductance varied from a high of 400 micromhos to a low of 265 micromhos on October 29 following a rainstorm. Figure 1 summarizes monthly variations of specific conductance and other quality characteristics for the San Lorenzo River at Big Trees from 1952 through 1964.

This quality represents approximately equal portions of water from the west side and east side of the main stem. Water from springs and tributaries on the west side are generally of better quality than those entering from the east side of the main stem. Specific conductance of samples from the west side streams at the confluence with the main stem during the investigation ranged from 161 micromhos to 304 micromhos. During the same period, specific conductance of streams entering from the east side including the upper reaches of the main stem ranged from 312 micromhos to 924 micromhos. Values for specific conductance and total dissolved solids throughout the San Lorenzo River system

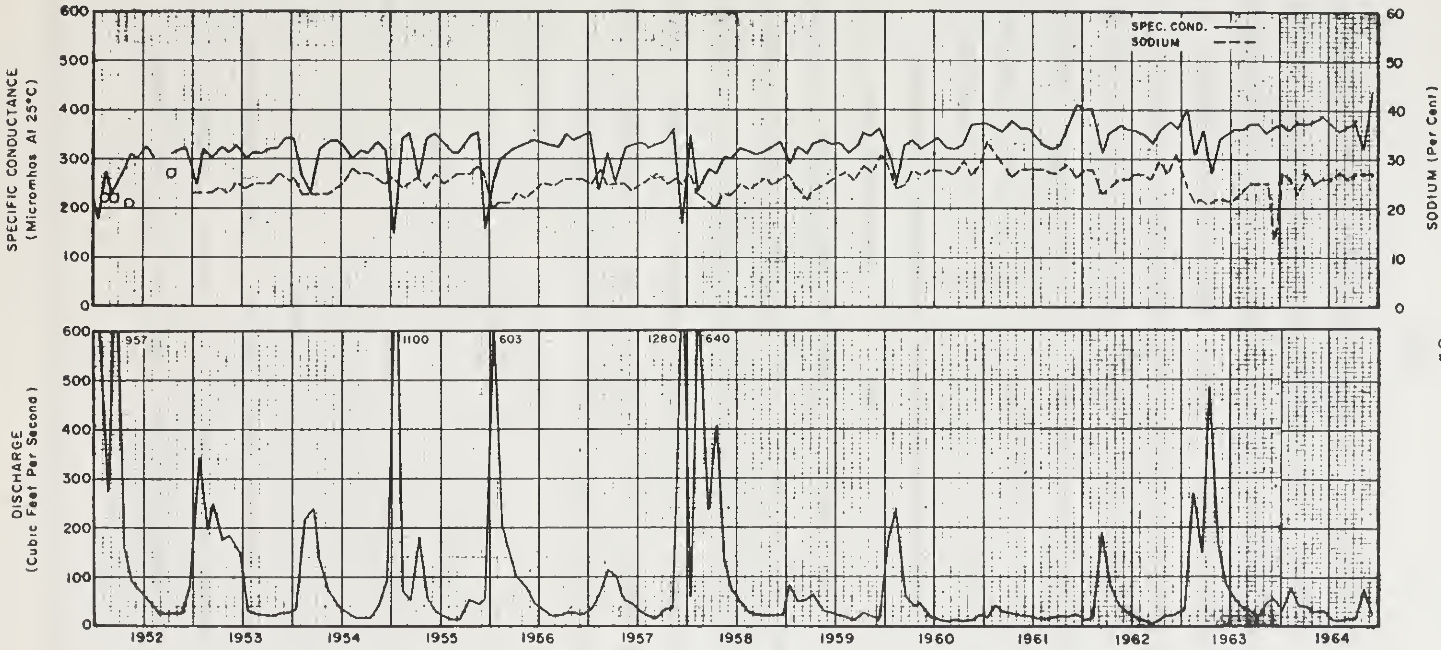

Figure I
QUALITY AND QUANTITY VARIATIONS
SAN LORENZO RIVER AT BIG TREES

generally were well within the limits for beneficial uses discussed under water quality criteria.

Hardness. Total hardness of surface water in San Lorenzo River watershed shows much the same pattern as total dissolved solids. The west side streams vary from 57 to 129 ppm, while the east side streams range from 98 to 301 ppm total hardness. Thus, water from the west side would be considered soft, whereas it may be desirable to soften by treatment some of the east side surface waters if used for domestic supply.

Major Constituents. The major chemical constituents of natural waters generally are considered to be the cations (calcium, magnesium, and sodium) and the anions (bicarbonate, sulfate, and chloride). Nearly all the surface water in the San Lorenzo River watershed is of the calcium bicarbonate type, although the east side tributaries show a higher portion of sulfate than do the west side streams. Concentrations of individual major constituents generally vary in the same degree and from the same causes as concentrations of total dissolved solids. None of the major constituents in the San Lorenzo River system approached the limiting values described under water quality criteria.

Minor Constituents. Nitrogen in natural waters is usually the result of decaying organic matter which may be of sewage origin, although it is also present in fertilizers. Concentrations of nitrate in the San Lorenzo River system generally were less than 1.5 ppm. Notable exceptions included Bean Creek where, during the investigative period, nitrate concentrations ranged from 1.5 to 3.2 ppm. This resulted in a concentration as high as 2.3 ppm in the lower reaches of Zayante Creek even though the upper reach never exceeded 1.8 ppm. Even higher concentrations of nitrate were encountered in Branciforte Creek, where concentrations ranged from 0.6 ppm to 13 ppm.

Phosphate in water is often the result of domestic waste, since it is present in sewage and in nearly all commercial soaps and detergents. It is also usually present in commercial fertilizers for soils deficient in natural organic phosphate. Concentrations of phosphate were generally less than 0.4 ppm in the San Lorenzo River system upstream from Felton. One exception is the upper reach of the main stem near Waterman Switch, where phosphate concentrations generally varied from 0.4 to 0.7 ppm. This was traced to the only dwelling in the immediate upstream vicinity where a home laundry discharge was being made directly to the streambed of a small tributary of the river. Love Creek also exhibited higher phosphate concentrations, ranging from 0.5 to 0.75 ppm. This again probably can be attributed to a sewage origin, since a wading survey of Love Creek revealed evidence of a direct discharge of sewage to the stream.

In the lower reaches of the San Lorenzo River system, even higher concentrations of phosphate were encountered. Concentrations in Bean Creek ranged from 0.7 to 2.4 ppm phosphate, which, together with the higher nitrate concentrations, suggests degradation from a man-made source. Although a direct laundry discharge was noted in the Mount Herman area, near the mouth of Bean Creek, some of these nutrients probably originated from drainage from the middle or upper reaches of Bean Creek. Lompico Creek also showed moderately high concentrations of phosphate, ranging from 0.38 to 0.70 ppm. Concentrations of phosphate persist through the lower reaches of Zayante Creek and even into the main stem, where concentrations as high as 0.7 ppm have been found at the Santa Cruz check dam. Concentrations of phosphates in Branciforte Creek ranged from 0.34 to 1.1 ppm.

Despite the higher than average phosphate concentrations in some tributaries, sewage origin could not be confirmed by analyses for ABS detergents. All major tributaries as well as the main stem of the San Lorenzo River were analyzed for ABS, and all results were negative. Foaming was observed in many places in the river system, but this apparently was caused by some substances other than ABS, since ABS concentrations must exceed 0.5 ppm to produce foam.

Heavy metals have been measured in the San Lorenzo River at the Big Trees station approximately twice a year since 1952. Iron has been the only heavy metal which has exceeded the United States Public Health Service recommended limits for treated water of 0.3 ppm of iron. In addition to iron, our standard heavy metals analysis includes aluminum, arsenic, copper, lead, manganese, zinc, and chromium, but this analysis is quite expensive. Therefore, during the investigative period, unfiltered samples from most stations were analyzed for total iron only. The west side tributaries showed very small concentrations of iron, but several stations on the main stem as well as several of the east side tributaries showed iron concentrations well above the 0.3 ppm recommended limit for treated water. Among the latter, maximum concentrations of total iron from unfiltered samples were as follows: San Lorenzo River at Waterman Switch, 0.43 ppm; upper Bear Creek, 1.8 ppm; Newell Creek, 0.51 ppm; San Lorenzo River near Felton, 0.89 ppm; Zayante Creek near Felton, 0.73 ppm; Zayante Creek at Zayante with a high of 7.8 ppm; Bean Creek, 1.2 ppm; and Branciforte Creek, 0.88 ppm. The highest iron concentrations occurred during periods of heavy flow when turbidities were also high. This indicates that perhaps a large portion of the total iron was carried by suspended sediments. On May 12 and 13, 1964, samples were collected from the sites of three proposed dams: San Lorenzo near Waterman Switch, upper Bear Creek, and upper Zayante Creek. These samples were filtered before being analyzed for a wide range of heavy metals which included, besides iron, the following: aluminum, beryllium, bismuth, cadmium, chromium, cobalt, copper, gallium, germanium, lead, manganese, molybdenum, nickel, titanium, vanadium, and zinc. Results of these analyses showed five parts per billion, or less, for all constituents, including iron.

Other minor constituents such as fluoride and boron were determined on several occasions but never exceeded any criteria limits.

Insecticides. The major potential problem of insecticides in water stems from the ability of the aquatic food chain to concentrate persistent insecticides (primarily chlorinated hydrocarbons). This could result in the trace quantities present in water and lower food chain organisms building up to toxic quantities in the higher members of the food chain, such as fish or fish-eating animals. The potential public health problem associated with drinking water now appears to be minimal but may pose problems in the future. Since so little is known about the toxicity of the newer insecticides to humans, no criteria have been established; however, Governor Brown's Committee on Pesticide Review has recommended a comprehensive program of research and monitoring.

Analysis of a sample collected August 4, 1964, from the San Lorenzo River at the check dam showed only traces (less than 10 parts per trillion) of insecticides such as DDT and DDD. Fish bioassays have shown the 96-hour TLm (median tolerance limit) values range from

16,000 to 43,000 parts per trillion of this type of insecticide depending on the species of fish being tested.

Biochemical Oxygen Demand (BOD). The five-day BOD indicates the degree of unstabilized organic pollution, from either domestic or industrial sources, to which the stream is being subjected. Analysis of a sample collected August 4, 1964, from the San Lorenzo River at the check dam showed a five-day BOD of 0.6 ppm. For comparison, the five-day BOD of raw sewage generally exceeds 100 ppm.

Bacteriological Quality

Despite the fact his available field and laboratory personnel were very limited, the Director of Sanitation, Santa Cruz County Health Department, volunteered to conduct a coliform sampling program of the San Lorenzo River and tributaries. Monthly samples (April through October 1964) were taken from 16 sampling stations extending from San Lorenzo Park, approximately six miles north of Boulder Creek, to the old Santa Cruz City Water Department intake near the mouth of the river. Locations of sampling points are shown on Plate 4, and analyses from all stations are tabulated in Appendix C.

The samples were analyzed in the county laboratory with exception of those taken on July 20 and August 17. On these dates, the county microbiologist was not available and the samples were mailed to the State Department of Public Health laboratory in Berkeley. These samples showed extremely high counts, which may have been caused by an overgrowth resulting from time in transit and undeterminable incubation temperatures.

The analyses showed sudden increases in counts greater than 1000 per 100 ml at many of the sampling points. For example, sample

Station No. 4 next to a bridge in the Riverside Grove area north of Boulder Creek had counts well below 1000 per 100 ml except for a period between August 3 and August 31, when the count jumped to 2400.

A possible trend is shown (Table 16) when the number of samples exceeding a base line MPN of 1000 per 100 ml are tabulated by months:

TABLE 16

SEASONAL DISTRIBUTION OF HIGH COLIFORM COUNTS

Month	Number of Samples Taken	Counts > 1000/100 ml	
		Number	% of Total Samples
April	16	1	6.2
May	16	3	18.5
June	16	4	25.0
July	16	4*	25.0
August	24	13*	50.4
September	15	5	31.2
October	16	2	12.5

* includes high counts from State Health Department analyses.

The field sanitarian during the sampling program discovered several incidences of septic tank seepages. One was located near Zayante Creek in the vicinity of sample Station No. 29. The sewage was found draining into a storm water drainage way which leads to Zayante Creek. The septic tank system was repaired in June. In August, sewage seepage was observed adjacent to Kings Creek and approximately 300 feet upstream from sampling Station No. 5. This condition was subsequently corrected. In the area near sampling Station No. 9, where Bear Creek enters the San Lorenzo River, at least three septic tank failures were noted near Bear Creek.

Valid conclusions cannot be drawn from the coliform sampling program recently completed. Limited field and laboratory time precluded the collection of cluster samples or adopting a more complete sampling schedule. That samples could be collected only on Monday mornings undoubtedly must also have a bearing on any conclusions which might be drawn.

However, it appears reasonable to observe that many of the high coliform counts resulted from human activity in San Lorenzo Valley. It also may be observed that the trend to larger permanent and transient population densities in San Lorenzo Valley area will result in higher bacterial loads in the river, with subsequent lowering of bacteriological quality.

Effects of Impoundments on Water Quality

Limnology deals with the physical, chemical, and biological conditions of fresh water, especially in lakes and reservoirs. Water in a reservoir is continuously in motion, and this motion often affects water quality. Water movement is caused by wind action, by inflow and outflow, and by variations in density and viscosity of water caused by changes in temperature. Such physical phenomena generally produce seasonal stratification of lakes and reservoirs. Seasonal stratification involves the annual establishment of the epilimnion and the hypolimnion, separated by the thermocline (Figures 2 and 3). However, each reservoir differs in size, shape, topography, location, and general development of its watershed. Therefore, factors influencing the behavior or water quality of one reservoir may not be applicable to another.

Limnology of Loch Lomond. Water temperatures in Loch Lomond range from about 9° to 24° Centigrade (48° to 75° Fahrenheit). The mid-summer thermocline is quite shallow (20 to 30 feet) compared with that of other reservoirs in the Bay area, in which the midsummer thermocline

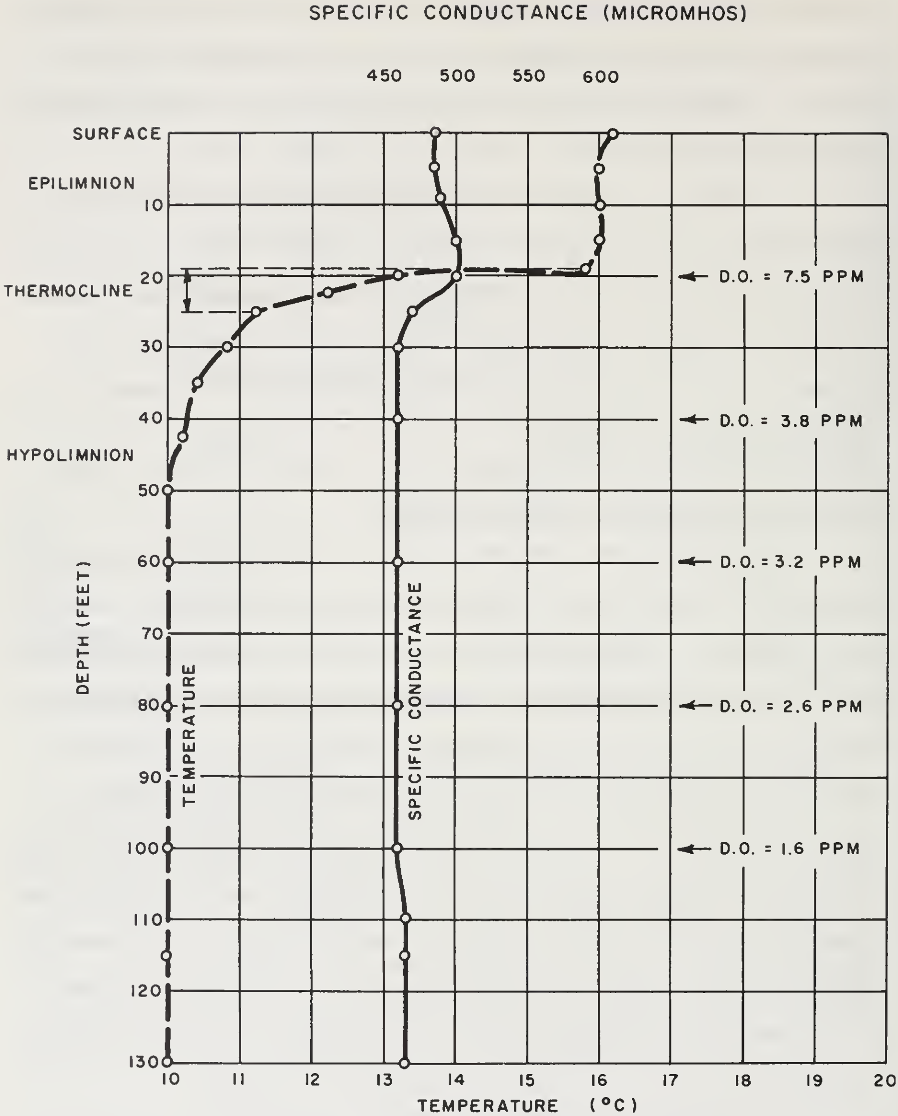

Figure 2. LOCH LOMOND TEMPERATURE, SPECIFIC CONDUCTANCE, AND DISSOLVED OXYGEN, VS. DEPTH – APRIL 23,1964

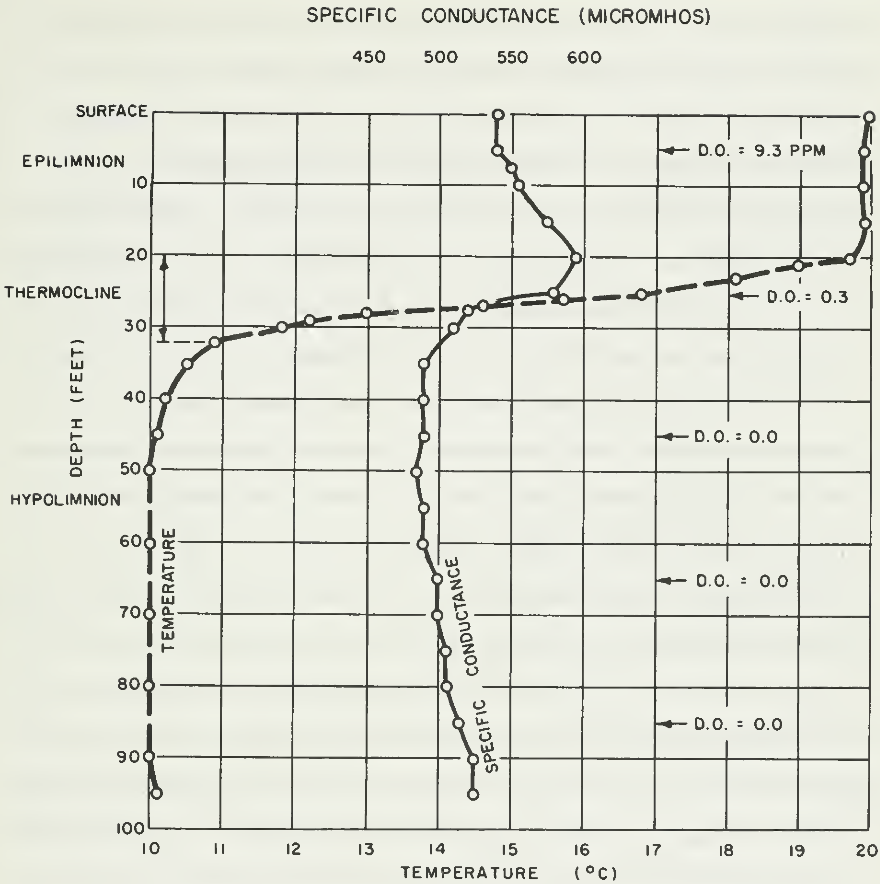

Figure 3. LOCH LOMOND TEMPERATURE, SPECIFIC CONDUCTANCE, AND DISSOLVED OXYGEN, VS. DEPTH - SEPTEMBER 22, 1964

usually occurs at depths greater than 50 feet. The shallower thermocline occurs in Loch Lomond because the temperature of the deeper water is influenced more by land than by air temperatures, since the reservoir is relatively deep and narrow. The thermocline is formed by higher temperatures of air in summer, which rather quickly warm the top 20 or 30 feet of water but have little effect on the deeper water.

Overturning or mixing of water in Loch Lomond is caused primarily by wind action but is aided by changes in the water temperature. During the fall, the temperature of the upper portion of the reservoir declines. The temperature difference between the epilimnion and the hypolimnion decreases until the thermocline disappears. This usually occurs during January or February and reduces the stability of the stratified water which, during the summer, resulted from the tendency of the warmer water to stay on top. Then the next strong wind storm causes water in the reservoir to start rolling and it overturns. This rolling continues until the following April or May, when a new thermocline begins to form. Figure 2 shows a young thermocline on April 23, 1964, and Figure 3 shows it as of September 22, 1964. Also shown are the effects of depth on specific conductance and dissolved oxygen.

Decomposition of organic material on the bottom of the reservoir produces significant amounts of hydrogen sulfide (H_2S). As the thermocline is formed, organic decomposition continues to produce H_2S and to deplete the oxygen in the hypolimnion. After this zone becomes saturated with H_2S, it begins to saturate the thermocline. During the summer of 1963, H_2S was first noticed in the thermocline during July. In the summer of 1964, it did not penetrate the thermocline until September. This appears to indicate that the rate of decomposition on the bottom of the reservoir is declining. Further aging of this young reservoir should minimize water quality impairment because of the extraction of solutes from the bottom organics and the covering of the bottom with inflowing inorganic sediments.

Plankton growth has been less active than would be expected in a new reservoir. A general cross section of organisms is present, but only three types have been identified in large numbers. These are Daphnia, Diatoma Vulgare, and blooms of Anabaena. Since the first two types have presented no problems, they are not discussed in detail. Anabaena blooms, however, cause taste and odor problems, so it is necessary to treat the reservoir two or three times a year with copper sulfate to control the growth of these blue-green algae.

Rainbow trout have been planted by the Department of Fish and Game each year since 1962, and a small fishing area was opened to the public in 1963. Creel censuses have indicated that these fish grow about six inches the first year and four inches a year after that.

Since quality data is very sparse for Newell Creek water before the dam was built, no direct analytical comparison is possible to determine the effect of the impoundment on water quality. However, water samples have been analyzed at least monthly since the reservoir was first filled, and no significant change or trend in the overall mineral or bacterial quality has been noted.

<u>Temporary Impoundments for Recreation</u>. The two main summer-season impoundments create swimming areas at Boulder Creek and Ben Lomond public parks on the San Lorenzo River. In addition, there are numerous small temporary dams of various degrees of effectiveness built by local residents or their children on most tributaries as well as on the main stem of the San Lorenzo River.

Such impoundments affect water quality primarily by slowing the water velocity. This often results in a condition that promotes the growth of algae and aquatic weeds.

Present Ground Water Quality

As mentioned in the introduction, some ground water (from the Santa Margarita Formation) is even less mineralized than the excellent quality water in streams draining the eastern slope of Ben Lomond Mountain. Well No. 10S/2W-10F, located in the sand-mining area between Newell Creek and Zayante Creek, was drilled through the Santa Margarita Formation to a depth of 212 feet. A mineral analysis (Table C-3, Appendix C) of water from this industrial well showed a total dissolved solids content of only 74 ppm, with silica (SiO_2) the predominating constituent. Determinations for iron (Fe) and detergent (ABS) were negative. This exceedingly low mineralization indicated that this ground water is recharged by direct precipitation rather than by nearby streams or subsurface movement of ground water from other geologic formations. Direct rainfall percolating vertically through the clean Santa Margarita sands has little opportunity to dissolve minerals from the relatively insoluble quartz grains.

At the other extreme is the relatively poor quality ground water emanating from springs just downstream from Newell Creek Dam (9S/2W-34G). This calcium sulfate type water carries total dissolved solids of approximately 700 ppm, but it originates in an area of consolidated sediments that are considered essentially nonwater-bearing.

Well No. 10S/1W-30K was dug to a depth of 37 feet in the Purisima Formation but probably bottoms in granitic rock. It is located about one mile southeast of Scott Valley and is used for garden irrigation. Analysis of filtered water from this well showed total dissolved solids of 400 ppm and a dissolved iron content of 2.2 ppm. An unfiltered sample collected at the same time contained 23 ppm of dissolved and suspended iron. Such a high concentration of iron makes this water very undesirable for domestic use without further treatment, but it is a Class 1 water for irrigation use.

The City of Santa Cruz has three wells close together near the check dam where surface water is pumped from the San Lorenzo River. These wells draw water from alluvium which normally is recharged by the river. On occasion, however, heavy pumping has caused sea water to intrude into the aquifer, resulting in chloride concentrations in excess of 1,000 ppm in waters from these wells. For this reason, and also because of relatively high iron and manganese concentrations in the water, the three wells have been put on a standby status for emergency use only.

The foregoing illustrations show that, from a quality standpoint, the Santa Margarita Formation is the best source of ground water within the San Lorenzo River watershed. However, this formation is not considered capable of sustained high yields because of limited recharge.

CHAPTER V. POTENTIAL WATER QUALITY PROBLEMS

Water quality problems may result from degradation either by natural or man-made causes; recreational activities may cause special water quality problems; and magnitude as well as potential sources of present and future degradation must be determined.

Natural Causes of Degradation

Erosion is often one of the major causes of degradation to water quality. Turbid or muddy water is not acceptable for domestic use, and many industries cannot use it. Treatment to remove the objectionable silt is often complicated and expensive. Siltation also damages fish spawning grounds and robs reservoirs of expensive, hard-to-replace storage space. Erosion is a natural process, but often is accelerated by human activities.

Another source of natural degradation is associated with the life processes of plant and animal life, either large or microscopic. Wood, bark, leaves, grasses, and ferns have a high BOD and produce many changes in water quality, such as the addition of color and significant quantities of algal nutrients. Probably one of the chief threats to quality from natural causes in the San Lorenzo River is production of algae and other aquatic growth. Man-made wastes often aggravate this problem.

Algae can cause tastes and odors in water supplies, clog filters in industrial and municipal treatment operations, interfere with manufacturing processes, kill or enervate fish by reducing dissolved oxygen, and discourage recreational water uses.

Man-Made Sources of Degradation

In the San Lorenzo River watershed, degradation from man-made sources appears to be greater than from natural causes.

Sand and Gravel Plant Operations

On May 27, 1964, the Central Coastal Regional Water Pollution Control Board, in cooperation with the Department of Water Resources and other interested agencies, inspected sand and gravel plant operations in Zayante Creek watershed. Purpose of the inspection was to observe progress made in combating stream siltation resulting from erosion or waste discharges from the plants.

The inspection tour included examination of waste treatment facilities of: Central Supply Company; Henry J. Kaiser Company; Pacific Cement Aggregates, Incorporated; and Santa Cruz Aggregates Company. In addition, present stream conditions were observed at several locations.

The first stop was made at the confluence of Zayante Creek with San Lorenzo River near Felton. Although the water appeared clear, there was evidence of recent sand deposition. Turning over rocks in the bottom of Zayante Creek revealed an abundance of caddis fly larvae and other insects that serve as food for aquatic life.

Natural drainage from the Central Supply Company plant is to Azalea Dell Creek, a small tributary of Zayante Creek. The company maintains three holding ponds or settling basins at approximately equal elevations below three adjacent mined-out areas where erosion occurs as a result of rainfall. In addition, mined-out areas have been terraced and planted to a fast-growing cover crop. The seeded areas are stabilized by use of wire netting and straw and are watered by sprinklers. In the operation of this plant, wash water is recirculated and reused for grading and washing. Make-up water, when required, is supplied from a well which penetrates the Santa Margarita Formation to a depth of 212 feet.

A stop was made to observe Azalea Dell Creek near its confluence with Zayante Creek. The running water appeared clear, but about four inches of sand was observed in the bottom of a wooden diversion flume carrying water to a trout farm. The natural flow of Azalea Dell Creek is not great enough to support game fish.

Mining at the Henry J. Kaiser Company, Olympia plant on Zayante Creek has been suspended indefinitely. However, the plant facilities still are used for stockpiling sand brought in by truck and transshipped by rail. Some cover planting has been done.

Pacific Cement and Aggregates, Incorporated, maintains a series of five holding and settling ponds, one below the other with final overflow into Zayante Creek. A coagulant (quicklime) is used to aid the settling process. In the past, during periods of heavy rainfall, the ponds were sluiced out to maintain their capacity. Now, however, since the company plans to terminate mining in this area in 1966, its stated intent is to stop the sluicing and to abandon the upper ponds as they become filled with silt.

The Henry J. Kaiser Company, Mount Herman plant is the largest mining operation in the area; but since it is on the opposite side of the highway from Bean Creek, this plant is not an immediate threat to the stream system. Any major erosion or discharge crossing the highway undoubtedly would result in remedial action through protests of highway users. However, this plant appears to be operating in a satisfactory manner. Wash water is recirculated and some cover planting has been done.

Operation of the Santa Cruz Aggregates Company plant apparently has contributed largely to silt loads in the stream system. Silt and discarded fine sand have been dumped on the banks of Bean Creek. The slope of this material is steep and it is not cover planted. In addition, the method of operation has not included recirculation of wash water, since new water is readily available from the creek. Thus, until recently, used wash water has been flowing into Bean Creek carrying its full load of silt and fines.

Recently, operations have been improved somewhat by installation of a thickener (clarifier) in which wash water is treated before discharging to the creek. The president of the company promised additional improvements in his method of operations.

Construction Activities

Besides sand and aggregate mining, other industrial activities can result in man-made erosion. For example, if not properly planned, construction of roads or clearing of building sites can aggravate these problems considerably.

Following is a quotation from "Water Newsletter" of December 6, 1963:

> "Agricultural Research Service experts are pressing for complete soil and water conservation planning, prior to any construction, for entire watersheds that are subject to urbanization. They believe that the cost of erosion control should be included in the total expense of urban development because silt control is as essential as providing other community facilities."(2)

Logging Activities

Around the turn of the century, careless logging practices left great volumes of forest debris in the various tributaries of the drainage basin. Over the years, this material formed hundreds of debris jams.

These jams were quite effective in blocking the migration of salmon and steelhead to their historic spawning grounds. In addition, the jams and related siltation significantly altered the spawning and nursery areas, undoubtedly contributing to the reduction of salmonoid production. During the early 1960's, under the auspices of the Wildlife Conservation Board, the drainage basin was cleared of these jams, and efforts were made to re-establish the anadromous fish population to higher levels of abundance through a stocking program. In March 1959, the San Lorenzo River system was stocked with 38,000 yearling silver salmon. In 1963 and 1964, an additional 40,000 silver salmon yearlings were planted.

The primary problem still facing the fishery resources of the San Lorenzo River system is the reduction of spawning and nursery habitat by activities such as logging, road building and maintenance, homesite development, and sand and gravel operations. These activities all have contributed to excessive amounts of erodible materials (silt and sand) being introduced into the aquatic environment. The silting effect has altered the fishery resources potential by smothering spawning areas, by smothering aquatic food organisms on which the developing young fish depend, and by reducing shelter areas.

Thus, any increase in the steelhead and silver salmon resources depends on improvement of the overall habitat and on maintenance of high water quality of the drainage. To meet this goal, stringent erosion control measures must be taken.

Sewage Disposal

In nearly all the more heavily populated areas, one of the major causes of man-made degradation of water quality is the discharge of waste effluent to streams. As development continues, raw water supplies contain increasing proportions of diluted sewage effluent from upstream communities. Although this type of degradation has not been a serious problem in the San Lorenzo River system because direct discharge of sewage to the streams has not been sanctioned, there is a limit to the volume of sewage that can be handled by septic tanks or other means of disposal to land. Water use and reuse will certainly increase with growing population and industry. Consequently, rigorous standards for acceptable quality of waste effluent appear inevitable.

Up to now, users of surface water have depended on the assimilative and dilution capacity of receiving waters to absorb wastes and to maintain acceptable water quality. Although this capacity is limited, it will be increasingly important to accommodate that degradation from land use which is beyond practical control. This includes the effects of application of herbicides, pesticides, and other commercial insecticides, natural and applied soil nutrients, eroded materials, and return irrigation contributions. Although by rigid controls degradants and potential pollutants may be kept to a minimum, it is unlikely that they can be eliminated entirely.

Recreation

The ever-increasing population makes demands. More people, with more and more recreational time on their hands, are demanding access to what appear to them to be desirable, unused, and wide-open spaces. In regions of high population density, the demand for more recreation areas is acute. At the same time, the need for maintaining usable quality in waters becomes more pressing.

Esthetic Objections. A number of years ago, an engineer for one of the California utilities permitting recreation on reservoirs made the following pertinent observation concerning esthetics:

"Recreation brings to the reservoir area many things offensive to the eye and nose, the principal objectionable materials being the various forms of excreta from the human body and things incidental thereto. Others are refuse from fish cleaning tables, remains of food and food containers, newspapers, cigarette packages, and empty bottles. These things can be all attended to so that the safety of the water is not affected, provided that proper facilities are installed, proper regulations prepared and enforced, and provided they are earnestly observed by patrons.

"The modern treatment plant can make the water safe but cannot erase the thoughts or feelings of those whose esthetic ideals have been outraged by unsavory sights incident to recreation as it is generally practiced . . . ." (24)

Conflict of Interests. The economic aspects of watershed management and reservoir and stream use, not compatible with maintaining the original water quantity or quality, point to increased costs of policing, increased costs of water treatment, legal liabilities, and potential loss of a resource through forest fires.

The social and public relations aspects of noncompatible uses point to having to yield to pressure groups, to creation of bad public relations unless the anticipated services and facilities measure up to what the public expects, and to bad public relations because water quality control cannot permit the granting of all public requests. One must also remember that all regulations are in some part objectionable to most people(1).

The practice of littering is definitely not on the decline in spite of fines and restrictive laws. Public attitudes, starting with the education of the child, must be changed if the future is to become a source of inspiration rather than one of frustration to those interested in maintaining the usefulness of our water resources.

Magnitude of Degradation

An attempt was made to determine the magnitude of degradation (if any) to water flowing in the San Lorenzo River at Big Trees. This station has been sampled monthly since 1952 for many of the dissolved mineral constituents of water. However, concentrations of most of these minerals fluctuated so widely, particularly with variations in flow rate, that a long-term trend is difficult to discern. Figure 4 shows three consecutive four-year periods in which specific conductance (representing total dissolved solids) is plotted versus the discharge rate at Big Trees. Theoretically, the slope of these curves should always be negative, showing improving quality with increasing flow. However, it is possible that several consecutive dry years could cause effects that would carry over into a wet year, or vice versa. An example of this (which has been observed in other areas) would be natural quality degradation of springs or ground water seepage following a period of drouth.

Comparison of the three four-year periods in Figure 4 shows little difference in quality at high flows (greater than 50 cfs). In the range of 20 to 30 cfs, however, the last four-year period (1960-63) shows a quality degradation of approximately 30 micromhos (18 ppm dissolved solids) compared with either the 1956-59 or 1952-55 periods.

Surprisingly, when flows at Big Trees fell below 15 cfs, there was a slight improvement in quality. This might be explained by differences in quality and quantity of dry-weather flows in the east side versus the west side tributaries in the San Lorenzo Valley above Big Trees. The poorer quality east side springs and tributaries have a greater tendency to dry up in the late summer and early fall; the better quality west side tributaries maintain a more constant dry-weather flow.

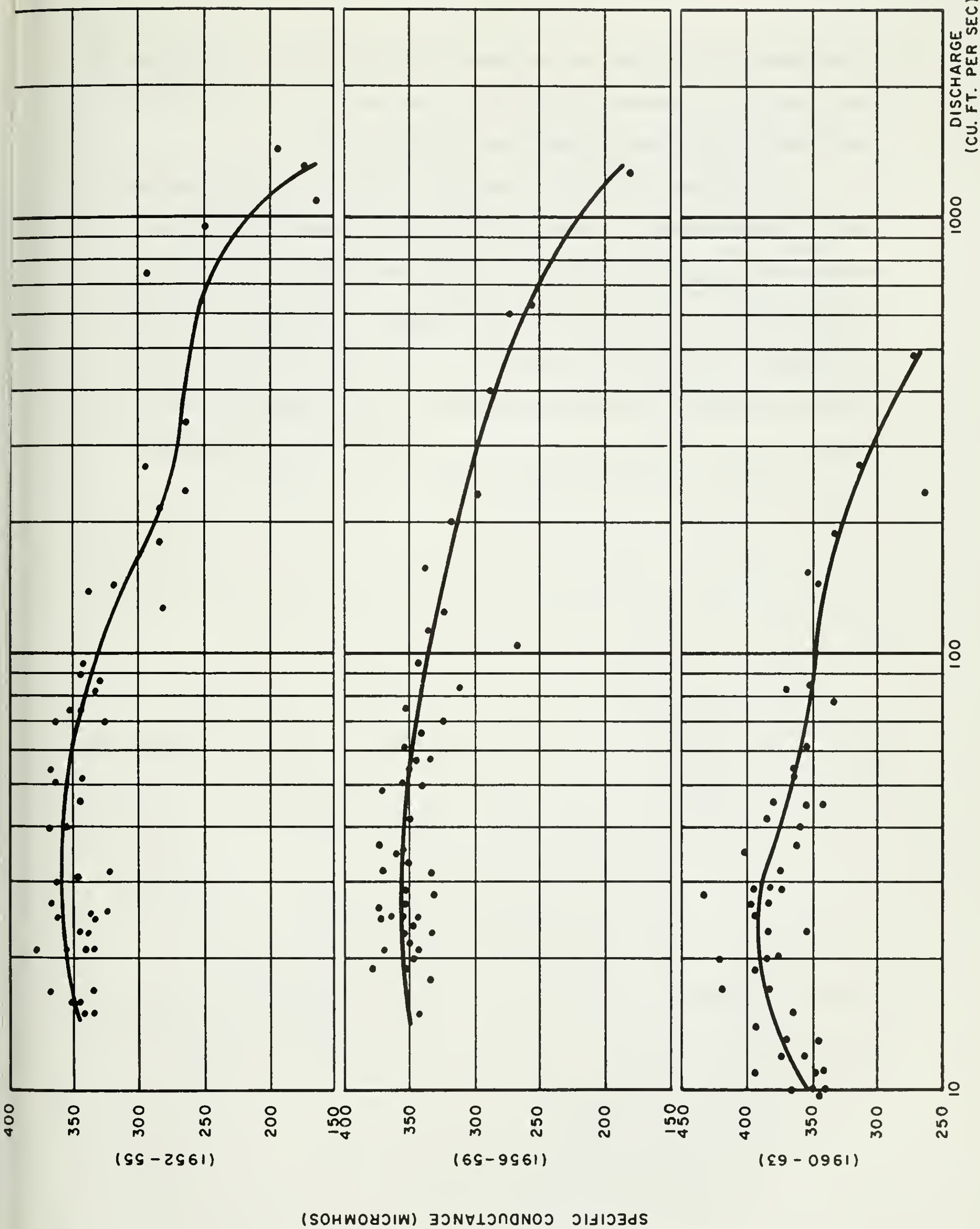

Figure 4. SPECIFIC CONDUCTANCE VERSUS DISCHARGE
SAN LORENZO RIVER AT BIG TREES

Thus, when the discharge at Big Trees is 10 cfs, a larger percentage of the total flow originates in the better quality west side tributaries than when the discharge at Big Trees is 20 or 30 cfs.

From the foregoing discussion, it is apparent that available data is insufficient to accurately correlate degradation with time or to predict the magnitude of future degradation of water quality in the San Lorenzo River. However, Figure 4 and Figure 1 in Chapter IV, taken at face value, indicate that some degradation has occurred since 1952. Further, it must be surmised that without positive action to alter these apparent trends, additional degradation of quality must be expected.

CHAPTER VI. PLANS FOR MAINTAINING OR IMPROVING WATER QUALITY

At present, the magnitude of degradation in the San Lorenzo River system has not reached alarming proportions. In fact, runoff from the San Lorenzo River and its tributaries, with a few minor exceptions, is of very good quality and compares favorably with many other coastal California streams. By most parameters, water in the San Lorenzo River system is superior to the United States Public Health Service Drinking Water Standards and many other criteria for good quality water as listed in the first part of Chapter IV.

The question then arises, how much degradation should be sanctioned? Should waters in the basin be allowed to degrade to the upper limit for acceptable water quality? To allow for future contingencies in growth and water uses, it seems prudent that the goal should be to stop the anticipated increase of degradation before the upper limit, which could be tolerated for the highest beneficial use, is reached. Although it was not within the scope of this investigation, other studies have shown that maintenance or improvement of water quality provides concrete economic benefits, some of which can be measured in dollars and cents[30].

Water Quality Objectives or Goals

Adoption of water quality objectives would serve several very important purposes. They would provide a basis for maintaining suitable water quality for all present and anticipated beneficial uses in the San Lorenzo River watershed; they would assist construction agencies and all dischargers by setting forth goals which could be used for planning and operation; and they would form the basis for establishing water pollution control programs in the area. Following are excerpts quoted from a policy statement of the Central Coastal Regional Water Quality Control Board. The entire text of the policy statement, as well as other documents of the Board pertinent to the San Lorenzo Valley, is included in Appendix B.

Policy for Protection of Beneficial Uses

"Since the San Lorenzo River and its tributaries constitute a principal domestic water supply source at all locations in the Basin, discharge of sewage directly to the River or its tributaries is not considered acceptable. Community waste disposal within the watershed is a recognized necessity, particularly in view of present and anticipated residential developments. With these factors in view, it is declared to be the policy of this Board to prevent waste discharges over which it has jurisdiction from creating conditions which would unreasonably impair these stated beneficial water uses.

"In keeping with this policy, the Board makes the following determinations with respect to existing and planned domestic waste discharges:

1. In accordance with Section 13054.3 of the California Water Code, no direct discharge of wastes into the San Lorenzo River, its tributaries, or to domestic water supply reservoirs will be permitted.

2. Land disposal under suitable conditions is deemed a proper and acceptable method of sewage effluent disposal within the San Lorenzo River watershed. 'Suitable conditions' shall be considered to include all of the following factors, which are associated with the land disposal of effluent:

    a. The discharge shall be maintained on designated land disposal area without overflow or bypass to other properties or drainageways at any time.

    b. There shall be no runoff from the land disposal area which contains detectable quantities of sewage effluent.

    c. Conclusive evidence shall be provided, prior to the time that treatment works are constructed and placed into operation, that sufficient land is available to provide disposal by percolation and evaporation, and that overflow will not occur under simulated operating conditions.

    d. Land disposal areas shall have isolation from residential developments to preclude public access and nuisance conditions from occurring which may affect adjacent properties.

    e. A bona fide responsible operating agency shall be available which is capable of maintaining and operating the proposed sewage treatment and disposal works.

3. Sewage treatment facilities which may be constructed shall include safeguards necessary to prevent any discharge to other than a designated land disposal area and to prevent the discharge of improperly treated wastes to the disposal area. There shall be provisions for a standby power supply to operate essential units of the treatment and disposal facilities at all times.

4. Since it is contemplated that an overall sewerage system will ultimately be constructed which will remove wastes from the Basin for disposal, localized land disposal facilities are considered to be of an interim nature. Requirements for waste discharge shall provide that the local disposal systems are to be abandoned in favor of any available outfall system which will remove wastes from the San Lorenzo River Basin for disposal in the Pacific Ocean.

Objectives

"When considering the establishment of requirements for specific waste discharges, the Board will be directed by the following objectives relevant to the particular discharge conditions:

1. Public Health. The Board shall take cognizance of public health hazards associated with waste discharges and require effective treatment and disposal for wastes which may contribute to such problems.

2. Esthetic Considerations. All waste discharges shall be treated and controlled to preclude the appearance of objectionable matter in the disposal areas. Discharges shall not cause unsightliness due to sludge deposits or slime and fungus-type growths in the disposal area. Discharges shall not cause odor nuisance in recreational, residential, or other areas readily accessible to the general public.

3. Toxic Substances and Mineral Constituents. No substance shall be present in the discharge in a concentration which would be deleterious to human, plant and animal life. Dissolved minerals shall not be present in the percolating wastes in concentrations which will render receiving waters unsuitable for recognized beneficial uses.

General Considerations

"It shall be the Board's policy to encourage, wherever possible, the consolidation of sewerage systems. The advisability of locating two treatment plants in close proximity should be seriously questioned on the basis of capital investment and maintenance costs. From the standpoint of pollution control, it is not desirable, as experience has shown that frequently small plants do not receive the necessary maintenance or operation to consistently produce a high quality effluent.

"When requirements are prescribed for a particular waste discharge in the area, the Board may prescribe a monitoring program to be carried out by the waste discharger. The monitoring program may include the following: provision for sampling and analyses of waste discharge and receiving area and submission of reports to the Board. Samples shall be analyzed for various bacteriological, chemical and physical characteristics. Location of sampling points and frequency of analyses shall be sufficient to insure compliance with the policy and requirements of the Board which apply to the particular discharge.

"This policy statement shall be used by the Board as a guide when establishing requirements for waste discharges. However, requirements for each disposal will be determined on a case-by-case basis.

"Should conditions of water use change materially, this policy statement and all requirements applicable to the area may be reviewed by the Board to determine if modifications are warranted to meet the changing needs of the area."

The above excerpts are direct quotations from "Policy Statement for the Discharge of Sewage Effluents in the San Lorenzo River Basin", which was adopted October 10, 1963, by the then Central Coastal Regional Water Pollution Control Board. In 1965, through action by the State Legislature, all regional water pollution control boards became regional water quality control boards with some change in their responsibilities.

Water quality control, insofar as the regional boards are concerned, is to be achieved through formulation of water quality control policy in coordination with the State Water Quality Control Board. Regional boards currently are authorized to regulate waste discharges in the attainment of water quality objectives; while other factors affecting water quality are controlled through coordination with other agencies. Maximum attainment of water quality objectives thus requires close liaison among the regional boards, the State Water Quality Control Board, and other State and local agencies.

<u>Objectives for Specific Parameters of Water Quality</u>

The State Water Quality Control Board, in considering the formulation of water quality objectives, made the following statement -- "it should be noted and freely admitted that in a number of instances, the profession is in its infancy insofar as understanding the many facets of biological and biochemical interaction. The existence of these complex cycles is certainly being recognized. For example, in the so-called 'Red Tide' wherein its effect is recognized but the 'triggering' water quality conditions cannot be fully described; so it will be with some of the water quality parameters we seek to set. At this point in time they are vague, even obscure, yet to the best of scientific and engineering judgment it is necessary to take up the task and not neglect the responsibility."

Keeping in mind the above quotation by the State Water Quality Control Board, Table 17 proposes long-term goals (limiting values) for specific parameters of quality of untreated San Lorenzo River water as measured at Big Trees.

Table 17 also lists historic values for some parameters which are well within criteria limits and for some parameters for which criteria have not been established or are not applicable to the water uses under consideration. In such cases, the limiting values proposed are of necessity more or less arbitrary. Objectives for noncritical parameters with observed historic highs well below criteria limits were established by using the historic high plus approximately 15 percent as the proposed limiting value. This method was applied to such parameters as specific conductance, total dissolved solids, sulfate, chloride, and boron.

Proposed limiting values for more critical parameters, such as coliform bacteria and nutrients (nitrate and phosphate), were reduced substantially from the observed historic highs.

Although many parameters listed in Table 17 may be important for future reference, some of them are not an immediate threat to surface water quality and therefore need not be monitored frequently. Such parameters (for which analytical determinations are quite expensive) include fluoride, biochemical oxygen demand, phenols, and most of the heavy metals. Also, constituents such as phenols evidence themselves by taste and odor before dangerous concentrations are reached.

TABLE 17

LONG TERM OBJECTIVES FOR SPECIFIC
PARAMETERS OF SURFACE WATER QUALITY

Parameter	CRITERIA LIMITS: Drinking Water	CRITERIA LIMITS: Recreation and Fish and Game	CRITERIA LIMITS: Irrigation	OBSERVED RANGE: San Lorenzo River System 1963-64	OBSERVED RANGE: Big Trees 1952-64	PROPOSED OBJECTIVES: Limiting Values as Measured at Big Trees
Alkyl Benzene Sulfonate (ppm)	0.5			0.0 - 0.1	0.0 - 0.1	0.0
Arsenic (ppm)	0.01				0.0 - 0.05	0.01
Biochemical Oxygen Demand (ppm)				0.6		1.0
Boron (ppm)			0.5	0.02 - 0.32	0.0 - 0.4	0.5
Chloride (ppm)	250		175	5.9 - 89	6.5 - 34	40
Chromium^{+6} (ppm)	0.05				0.0	0.0
Coliform Bacteria (MPN/100 ml)	± 1	1,000			130 - 700,000	1,000 1/
Color (units)	15			0 - 35		15
Copper	1.0	0.05		0.0 - 0.0025	0.0 - 0.06	0.05
Dissolved Oxygen (ppm)		(5-9)		3.7 - 15.0	8.5 - 14.1	6.0 1/ - 8.0
Fluoride (ppm)	0.6-1.7 2/			0.1 - 0.5	0.09 - 0.3	0.6
Hardness (ppm as $CaCO_3$)				57 - 301	59 - 159	160
Hydrogen Ion Concentration (pH)		6.5-8.5		6.0 - 8.7	6.8 - 8.6	(6.5-8.5) 1/
Iron (ppm)	0.3			0.01 - 7.8	0.0 - 0.26	0.3
Lead (ppm)	0.05				0.0	0.05
Manganese (ppm)	0.05			0.01	0.0 - 0.01	0.05
Nitrate (ppm)	45			0 - 13	0.0 - 2.8	2.0
Pesticides (ppm)				trace		
Phenols (ppm)	0.001					0.001
Phosphate (ppm)				0.02 - 2.4	0.15 - 0.75	0.5
Sodium (%)			60	15 - 36	14 - 34	
Specific Conductance (micromhos)			1,000	161 - 924	168 - 433	500
Sulfate (ppm)	250			9.0 - 110	24 - 53	60
Temperature (F)		32-65		35 - 76	43 - 77	65
Total Dissolved Solids (ppm)	500		700	105 - 590	102 - 263	300
Turbidity (inits)	5			0 - 40	0.6 - 2,400	5 (dry weather)
Zinc (ppm)	5	variable		0.005	0.0 - 0.03	

1/ Objectives for entire stream system

2/ See Table 11

However, it is important to sample at least once a year for insecticides (primarily chlorinated hydrocarbons), using the best analytical procedure available. Table 17 does not list an objective for these new pesticides, since no criteria have been established and so little is known about their toxicity to humans; however, Governor Brown's Committee on Pesticide Review has recommended a comprehensive program of research and monitoring.

Possible Projects to Improve Water Quality

Physical works or projects which may affect water quality include such things as construction of dams and reservoirs, improved waste treatment and disposal plants, and projects to control erosion and surface water turbidity.

Construction of Dams and Reservoirs

Impounding surface water in large reservoirs, properly designed and operated, generally is considered to improve the overall year-around quality of water for domestic or municipal use. Bacterial counts often are lowered; and physical characteristics, such as temperature and turbidity, generally are improved. More importantly, however, a reservoir with a large storage ratio and multiple level outlets often can release water of a fairly uniform quality the year around. This is of great benefit to a treatment plant, since once a satisfactory water treatment process has been established, it can be continued with a minimum of modifications necessitated by seasonal fluctuations in water quality. Thus, the operator of a water treatment plant may prefer a raw water supply of slightly poorer but constant quality over a water that is sometimes of better but variable quality.

Full development of the San Lorenzo River watershed undoubtedly will require construction of several more dams and reservoirs. The number of suitable reservoir sites on suitable streams is fixed. In some regions, the demand of communities for land for industry, for subdivisions, and for super highways has resulted in the loss of many of these available sites. Some areas can be used for agriculture and many others can be used for residential and industrial development. However, areas suitable for reservoir construction are limited by topography, hydrology, geology, and sometimes by water quality considerations. Conflicts of interest and injury to some cannot be avoided entirely if reservoirs are to be built. However, designation of a suitable reservoir site as early as possible may provide a basis for preserving land from conflicting purposes and help to avoid subsequent controversy.

Waste Disposal

When communities are small and isolated, they usually can discharge waste without harm to others. However, as these communities grow and their boundaries approach each other, they cannot with impunity rid themselves of their waste. One community's waste tends to become a part of another community's water resource. This is becoming an increasing threat to the water resources of the San Lorenzo River watershed.

There are two basic solutions to the growing problem of waste disposal -- (1) export of waste with little or no treatment and (2) intensive treatment enabling reclamation and reuse of the waste water. Between these two extremes, there are many alternative combinations.

Assuming a plentiful water supply and sufficient capital, the simplest solution for the disposal of the wastes in the San Lorenzo River Valley would be to collect them at a central point, pump them out of the valley, and discharge them through a long outfall far into the ocean. For the immediate future, however, such a solution probably would be impracticable due to the high cost of such an undertaking.

In such a situation, the possibilities of so-called "tertiary" treatment should be considered, with possible reuse of waste so treated for a water supply where somewhat lower quality than that required for drinking water would be satisfactory. Depending on the demand, such uses might include irrigation of crops, lawns, golf courses, and parks; and fire protection.

A third possibility for a waste disposal project would be community collection, primary and secondary treatment, with disposal to the underground. The success or failure of such a project depends almost entirely on the geology and hydrology of the underground formation. It can be quite successful where underground conditions are ideal; it can be quite unsatisfactory where underground conditions are such that the waste is free to move into usable bodies of surface or ground water before the objectionable materials are filtered out or rendered innocuous through natural processes. Each prospective waste disposal site must be approved or disapproved on its own merits after intensive study and actual testing of the ground water strata and overlying soil.

Projects for Control of Erosion and Surface Water Turbidity

Erosion can be controlled to a great degree by planting cover crops, by terracing and channeling, and by construction of check dams and settling ponds. The United States Department of Agriculture Soil Conservation Service in Watsonville has provided the following advice for the planting of cover crops in the sand mining areas.

> "The area to be planted should be smoothed to the flattest slope possible but in no case greater than 1-1/2 to 1. Prior to the rainy season, fertilize the slope with 500 pounds per acre of 16-20-0 fertilizer and plant with Blando Brome seed at the rate of 20 pounds per acre, or use other suitable fast growing plants. Then mulch with approximately three tons per acre of barley straw and anchor into place with a jute or kraft erosion netting."

After the slopes are stabilized, a more permanent type of vegetation can be planted, particularly if water is available for irrigation.

Where slopes are too steep, terracing can be resorted to and runoff should be channeled into drainages of gentle slope. Where the gradient of the runoff is too steep, check dams and settling ponds are quite effective.

Properly planned and executed construction of roads, subdivisions, other buildings, and preparation for logging activities can do much to control land erosion and the resulting silt load in streams. Good logging practices have accomplished much toward saving watersheds and streambeds from silt pollution and high turbidities.

The following are a list of procedures recommended by the State Department of Fish and Game:

1. "Oily or greasy substances, or other material harmful to fishlife, originating from the contractor's operations, shall not be allowed to enter, or be placed where they will later enter a live stream.

2. "Maintain a 50-foot wide buffer strip on either side of stream in which non-commercial vegetation is disturbed as little as possible.

3. "Avoid upstream or downstream skidding in live or intermittent streambeds.

4. "Avoid log decking in streambed.

5. "For cross-stream skidding or repeated stream crossing with heavy equipment, a crossing should be constructed which will allow unobstructed flow of the stream.

6. "Fall trees away from stream whenever possible.

7. "Keep logging debris out of stream during operations.

8. "Divert runoff from steep erodable surface into low erosion hazard surface.

9. "When work is finished, make frequent water checks on skid trails, roads or cat tracks to reduce erosion.

10. "On steep hillside sections (slopes greater than 60 percent) near

a body of water, the road should be cut into the solid hillside and the waste material placed in selected spoil areas where overcast will not fall directly into stream channel."

Many of the above common sense rules would apply equally to new subdivision developments or other building or road construction.

Water Quality Management

The following quoted excerpts from a report of a water quality management program for the Delaware River Basin(16) gives some idea of the complexity of initiating a water quality management program.

"Consistent with the goal of obtaining maximum value from water resources, the objective of a quality management program may be defined as maintenance of conditions in a basin in such a way as will yield the greatest overall net benefit and achieving this in the most efficient manner.

"Since streams are called upon to serve many uses, some of which may be prejudicial to each other (such as water supply and recreation on one hand and the assimilation of waste on the other), quality management presents the problem of efficiently accommodating conflicts in use. This immediately poses the question: 'What are the benefits and costs of different kinds of accommodations?' Making such an assessment demands identification and evaluation of the detriments associated with quality degradation and of the range of alternative quality control measures. It calls for full and flexible exploration of all means that hold promise for achieving economies in a basin-wide system and their incorporation into the system where merited.

"To achieve net benefits, it is also essential to work out procedures to assure that large scale facilities, such as impoundments and stream flow regulations, be designed and operated so as to combine efficiently with facilities provided for individual sources of waste. The latter category includes, among others, the installation of waste treatment plants, processing changes which reduce wastes, and procedures for waste reclamation.

"Administration of such a program requires, among other things, a systematic formulation of effluent standards and/or a system of charges based upon quantity and quality of waste discharges to achieve the necessary coordination of alternatives."

Contamination Control

Water supply has been and will continue to be a potential for transmission of diseases. Outbreaks of water-born disease can occur when water sources are contaiminated with human sewage.

With specific reference to reservoirs, outbreaks of disease have resulted from the careless disposal by a few people of sewage that contaminated the immediate watershed of small reservoirs. The most recently recorded outbreak occurred at Keene, New Hampshire, in 1959. Today the risk still stems from the possibility that human sewage will not be properly controlled and, concurrently, that failure will occur in the safeguards provided.

Multiple factors of safety must be provided to offset events which can lead to contamination of a domestic water supply. This is important because perfection is rarely attainable in any single element of a chain protection. The multiple protective elements should include:

1. Adequate sanitary facilities at all recreation areas.
2. Continuous maintenance of these facilities.
3. Effective patrol of the recreation areas to assure reasonable conduct by the public.
4. An adequate program of surveillance by public health authorities.
5. A closed area surrounding the water supply intake.
6. Appropriate treatment of water before delivery to domestic water consumers.

Esthetic considerations are also significant. In recognition of this fact, California law requires that the State Board of Public Health, in acting on an application for a water supply permit, must determine that the water supply is, under all circumstances and conditions, "pure, wholesome, and potable".

Pollution Control

Pollution and contamination are closely related, may stem from the same source, and sometimes differ only in degree. Under the State Water Code, "contamination" means an impairment of the quality of the waters of the

State by sewage or industrial waste to a degree which creates an actual hazard to the public health through poisoning or through the spread of disease. "Pollution" means an impairment of the quality of the waters of the State by sewage or industrial waste to a degree which does not create an actual hazard to the public health but which does adversely and unreasonably affect such water for domestic, industrial, agricultural, navigational, recreational, or other beneficial use or which does adversely and unreasonably affect the ocean waters and bays of the State devoted to public recreation.

Although it does not provide numerical objectives, the policy statement (Appendix B) by the Central Coastal Regional Water Quality Control Board for the discharge of sewage effluent in the San Lorenzo River Basin is an important first step in adoption of water quality objectives and is one that this Department supports.

Construction of Most Feasible Projects

As has been pointed out earlier, the watersheds of our growing suburban areas are beginning to overlap. In some instances, communities are completely cut off from additional sources of water by the presence of other communities. Not only is a multicommunity development of water resources and/or waste disposal systems often necessary, but in many cases it can be economical. It has been shown that unit cost of such facilities decreases as the size of the facility increases. For example, the cost per gallon of transmitting water, including amortization, interest, taxes, insurance, operation, maintenance, pumping, and so forth, is less than half as much for a two million gallon per day supply as for a one million gallon per day supply, typical figures being $4.65 and $10.70 per million gallons per mile, respectively[20].

While the technological advantages of joint water supply or sewage disposal systems may be clear, the legal and administrative problems associated with them may be somewhat more complex, although there is no question that they have been met in many instances.

Whether new agencies for multicommunity water supply and waste disposal development are required is open to question. A modern city or county government with its improved professional level of administration can often do a better job with less confusion and waste than a new and untried unit of government.

The initiative for joint community action for any such multicommunity development must come from the local communities, since troublesome water and waste problems of the future probably will be related to growing urbanization. A solution of these problems will require greater involvement of local government in water management and a finer meshing of both urban and suburban planning. Legislation, both state and national, may be required to facilitate joint community action, but the initiative for this legislation and the responsibility for execution of projects must certainly remain with the existing local authorities where these are adequte to the task.

At the present time, the most feasible projects for additional new water supply for the upper San Lorenzo River Valley appear to be a dam and reservoir on either the mainstem of the San Lorenzo River at Waterman Switch or on Bear Creek just below its confluence with Deer Creek, or on both. From a water quality standpoint, a dam on Boulder Creek would be the most desirable; however, residential development has progressed to such an extent that the cost of right-of-way aquisition might be exorbitant. Farther south, the most feasible reservoir site is on the upper reach of Zayante Creek, just below the confluence of Mountain

Charlie Gulch. However, high concentrations of iron may increase the cost of treating this water for domestic use.

With respect to sewage disposal projects in the upper San Lorenzo River Valley, two or three medium size treatment plants may be all that can be financed and constructed in the immediate future. These plants could collect sewage from the immediately surrounding area, treat it intensively, and then either dispose of it directly to the underground, spray it on a suitable ground surface, or if there is a demand, reclaim it for park or golf course irrigation.

Operation of Completed Projects

There is a large area for water quality management in the optimum operation of water supply projects, especially with regard to the operation of reservoirs. This includes such things as selection of different strata of water from multiple level outlets or induced turnover to prevent stratification in reservoirs, the maintenance of minimum flows in streams which have been impounded, and "sweetening" or quality control by selective mixing of water from different sources.

Presently, a minimum flow of one cubic foot per second (cfs) must be maintained on Newell Creek by releases from Loch Lomond to avoid pooling or stagnant water downstream from the dam. Probably, a similar or even larger minimum flow should be maintained on Bear Creek and Zayante Creek, if dams are constructed. Since the summertime flow is normally less on the upper main stem near Waterman Switch, possibly a minimum flow of 1/2 cfs would be sufficient at that site. However, provisions for maintaining minimum flows should be flexible. Someone should have the authority to order increased releases of water to maintain adequate flows during critical periods. In the future, as recreational use of the river increases, it may prove feasible to construct dams and reservoirs for the prime purpose of maintaining minimum flows.

Land Use Management

In addition to specifying certain physical facilities to be undertaken and management techniques to be employed, a comprehensive water quality management plan should reflect the needs of the long-range future. Land use planning authorities should try to enforce restricted-use zoning of certain areas. For example, areas of potential reservoir sites can be identified and competitive development on them limited. Over a short term, this may be accomplished by zoning ordinances or by a preferential taxing policy as a reward for limiting development on the land to be reserved. Such steps, however, usually do not succeed for very long. For long-range needs, it generally is necessary either to purchase outright or to buy long-term options on the land. Similar action can be taken in regard to certain watershed areas, ground water recharge areas, and possible treatment plant sites.

Maintaining Favorable Environment for Aquatic Life and Recreational Facilities

When use for recreation has been accepted and approved by water utilities and health departments, both organizations are forced into the role of apologist for recreation by those who object on esthetic grounds and by the ultraconservative or the inadequately informed who fear the disease potential. It takes some courage to acknowledge the risks and, at the same time, to endeavor to keep them at levels commensurate with many other kinds of risks in daily existence.

It must be noted that basic conflicts of interest exist between those responsible for a safe, wholesome, and potable domestic water supply and those desiring to promote and develop recreation on streams or domestic reservoirs. A basic principle in water supply development has always been to obtain water supplies from the cleanest sources, to keep those sources clean, and to provide necessary treatment for a high-quality water. This is based primarily on the consideration that prevention of degradation is a much sounder approach from a sanitary standpoint than remedial measures after degradation has occurred.

A good fishery requires a "fertile" water and a complete biologic food chain. Thus, fishing interests have often strenuously objected to applications of copper sulfate for algal control as being damaging to the fishery.

Furthermore, in California, proposals have been made to add threadfin shad -- a small fish difficult to screen out of the intake -- to complete the food chain. The addition of fish poisons has been proposed or used to control "rough" fish in order to enhance the gamefish population. These proposals have usually placed the burden of evaluating the public health risks in the use of poisons upon water utility and public health officials[24]. Despite the problems already described, public health and esthetic needs can be met if adequate funds are available for facilities, maintenance, and patrol.

Past experience demonstrates that economic problems of recreation proposals have not been fully considered. "Who is to foot the bill for recreation? The recreationists, through fees? The water utility and, through it, the water-using public; or the public at large, through some type of tax-supported funds?" Experiences in California have demonstrated that few, if any, recreation facilities at domestic water supply reservoirs have been adequately supported by fees; therefore, adequate subsidy must be accepted as a principle and should be provided by the agency whose decision makes the recreation project possible.

The dilemma for water utility and public health authorities is that they must consider approving operations that are not clearly bad but which contain some elements of risk and which may create conditions objectionable to fastidious consumers. On the other hand, experiences in California indicate that a policy of prohibiting all recreational activity is not feasible. As a matter of tactics it would appear wise, where substantial public sentiment desires access to streams and reservoir areas, to decide what recreational activities can be tolerated and what controls and limitations are necessary in the public interest, and then strongly to defend the position taken.

Surveillance Program for Water Quality

Water quality in a stream system is never static; it changes continuously -- for better or for worse. Furthermore, quality may be improving in one reach while deteriorating in another. Therefore, it is an essential part of quality management to devise surveillance techniques to record, or preferably to predict, any significant quality changes in the stream system.

A surveillance program should include monitoring of quality changes (physical, chemical, bacteriological, and biologic parameters) and also visual inspection of physical conditions. The following minimum monitoring program is recommended to detect significant changes in water quality in the San Lorenzo River Basin.

a. Continuation of monthly sampling at the Big Trees station with the addition of annual or semiannual determinations for other appropriate parameters of the water quality objectives in Table 17.

b. Coliform sampling during the summer months at the community swimming areas, such as the public parks at Boulder Creek and Ben Lomond on the San Lorenzo River.

c. Occasional spot checks for specific conductance, dissolved oxygen levels, coliform densities, nutrient concentrations, and turbidities at tributary inflows and downstream from major waste discharges.

d. Intermittent visual inspections of the entire stream system.

e. More intensive follow-up surveillance, if required, to determine the source of any significant changes in quality which may occur.

Visual observations often may prove as valuable as the more sophisticated laboratory analyses. For example, a physical inspection may record the occurrence of oil or other floating materials, fish kills, or the source of an unknown waste discharge. The use of a color camera by the observer may be especially effective. When it becomes generally known in the area that there will be periodic unscheduled inspections and that pictures of violations will be taken, the resulting psychological impact alone may lead to more conscientious observance of pollution control.

CHAPTER VII. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The following paragraphs present a summary, conclusions, and recommendations resulting from a two-year investigation of the San Lorenzo River watershed. The recommended courses of action are subject to revision with changing conditions or with future changes in the water management objectives for the area.

Summary

The mild climate, scenic beauty, and attractiveness for water-oriented recreation has made the San Lorenzo River Basin an increasingly popular resort and recreation area. The number of permanent residents is rising and is expected to continue to rise as the University of California at Santa Cruz campus is developed.

In addition to the paramount water quality aspects, the scope of this investigation included determining water uses and the basic geology and hydrology of the area--all of which are important to the evaluation of water quality.

Water for municipal and domestic use and for recreation (including fish propagation and esthetic enjoyment) make up the major water uses in the watershed. Industrial and agricultural water uses are of lesser importance.

Because the mineral quality of water usually improves with increased flow, rainfall and runoff patterns affect water quality. Nearly 90 percent of the total annual rainfall at Santa Cruz occurs in the six-month period from November to April. The runoff follows the same general pattern during the six-month period from December to May. Thus, the higher flows of the best quality water are gone when the summer vacation season arrives.

Objectives of the investigation related specifically to water quality included the following:

1. Determine the present quality of water in various reaches of the main stem and in all the substantial tributaries of the San Lorenzo River, including the seasonal or other fluctuations in such quality.

2. Determine the sources and magnitude of present degradation of water quality within the watershed.

3. Define objectives or goals for specific parameters of water quality.

4. Determine the minimum continuing water quality monitoring program necessary to detect any future changes in quality of waters in the San Lorenzo River watershed.

5. Advise interested agencies on future water quality management practices, including recommendations for attaining specific water quality objectives.

6. Identify an appropriate organization with basinwide authority to execute a water quality management program.

The present quality of the surface water of the San Lorenzo watershed is generally good. Only in a few isolated instances did the grab samples show total dissolved solids, iron, and turbidities in excess of the United States Public Health Service drinking water standards. Bacteriological samples of surface water showed increased coliform densities during the late summer, when flows were low and human activity in the area was high.

Ground water generally is of good quality, but in some areas, notably Scotts Valley, it has a high iron content.

Erosion, both natural and that related to the aggregate and logging industries, and sewage disposal constitute important potential water quality problems in the watershed. Conflicting water uses could also become a problem in the future as San Lorenzo Valley becomes more fully developed. Such conflicts of interest could arise between recreationists and water service agencies, or between fishing interests and industrial water users.

Water quality objectives and goals are necessary to plan for the most efficient use of the water resources of an area. These goals can consist of general policy declarations by the Regional Water Quality Control Board and local government officials and the establishment of limiting values for specific water quality parameters.

Some form of water quality management by an agency with enforcement and/or persuasive powers is essential to meet the objectives adopted for the river basin. Construction of dams and reservoirs, close control of waste discharges, and installation of erosion control projects are all water quality management techniques applicable to the San Lorenzo River watershed. Some control over land use and a continuing surveillance program will also be necessary to provide for the optimum use of the water available to the San Lorenzo Valley area of Santa Cruz County.

Conclusions

1. Water for domestic and municipal use and for recreation, fish propagation, and esthetic enjoyment are the major beneficial uses of water in the San Lorenzo River Basin. These uses require water of relatively good chemical, physical, and bacteriological quality.
2. The San Lorenzo River system carries water of good quality, comparing favorably with other central coastal stream systems.
3. Degradation of the mineral quality of San Lorenzo River water, as measured at Big Trees since 1952, has occurred but its magnitude has not been alarming.
4. Existing and/or potential problem areas include:
   a. Silt deposition and turbidities resulting from erosion, both natural and as a result of human activity.
   b. Aquatic growths fed by nutrients (nitrogen, phosphorous, and other minor constituents) which result from surface runoff, recreational activities, and waste disposal.

c. Coliform densities at times of low stream flow in swimming areas resulting from heavy recreational use in combination with waste disposal practices.

5. Under present conditions of development in the San Lorenzo Valley, it appears that high silt and nutrient concentrations occasionally have resulted as much from natural land drainage as from human activities.

6. Continued residential development and increased recreational demand along the San Lorenzo River and its tributaries are certain.

7. Any future quality problems will involve conflicts of interest among the various water uses. Solutions to such problems may necessitate assigning priorities to those water uses which yield the greatest benefits.

8. Other investigations have shown that maintenance of good water quality has an economic benefit which can be measured in dollars and cents[30].

9. The present pattern of rainfall and runoff (90 percent of each occurring within six-month periods) makes the construction of additional storage reservoirs a physical solution to the low flow problem during the dry months.

10. No single local agency presently supplies either municipal water or sewer service to all the unincorporated communities of San Lorenzo Valley. From an efficiency standpoint, such centralization would be desirable.

11. An effective water quality management program is needed to protect the future quality (and quantity) of water in the San Lorenzo River watershed. Basic elements of such a program would include (but not be limited to) the following items:

    a. Objectives or limits for all significant parameters of water quality, as measured at appropriate points, similar to those proposed in Table 17.

b. A surveillance program to determine whether the objectives are being met.

c. Recommendations for feasible construction projects, optimum operation of reservoirs, maintenance of minimum flows, and land-use management.

d. Positive control of factors which could cause contamination, pollution, nuisance, or serious quality degradation.

Portions of such a program presently are being accomplished, but some aspects should be implemented or emphasized under future conditions.

12. The Department of Water Resources continually collects water-oriented data and has the mission of planning and directing the development of California's water resources to the end that the physical, economic, and social needs of the people will be met most effectively. Consequently, the Department of Water Resources can assist greatly in the implementation of an effective water quality management program.

Recommendations

Keeping in mind the philosophy expressed in the Preface, it is recommended that:

1. The Santa Cruz County Board of Supervisors:

    a. Recognize the major beneficial uses of water in the San Lorenzo River watershed as municipal, domestic, recreation, fish propagation, and esthetic enjoyment; and adopt tentative water quality objectives that are complementary to these beneficial uses.

    b. Sponsor an Advisory Committee composed of representatives from public and private agencies having water interests in the San Lorenzo River watershed.

2. The Advisory Committee should:

    a. Examine the beneficial uses of water and offer guidance in resolving conflicts of interest among the various water uses.

b. Support the water quality objectives and provide guidance for attaining these objectives through the voluntary or statutory activities of each participating agency.

c. Stimulate interest in plans for a sewerage system to serve all the unincorporated communities of the San Lorenzo Valley, including examination of the feasibility of reclaiming waste water.

d. Make recommendations for future development or enhancement of local water resources, encompassing:

   1. Plans for water supply including construction of dams and reservoirs.

   2. Optimum operation of completed reservoirs.

   3. Maintenance of minimum streamflows.

   4. Land use management, including zoning or other appropriate steps to preserve choice reservoir sites and potential sites for central water supply and sewerage facilities.

   5. Erosion control projects.

e. Identify an appropriate organization with basinwide authority to execute the water quality management program. Consideration should be given to establishment of a Zone of the Santa Cruz County Flood Control and Water Conservation District encompassing the San Lorenzo River watershed.

APPENDIX A

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BIBLIOGRAPHY

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APPENDIX B

DOCUMENTS OF THE CENTRAL COASTAL REGIONAL
WATER QUALITY CONTROL BOARD

The Resources Agency of California
CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD
1108 Garden Street
San Luis Obispo, California

Adopted October 31, 1963

POLICY STATEMENT FOR THE DISCHARGE OF SEWAGE EFFLUENTS IN THE SAN LORENZO RIVER BASIN

Introduction

Section 13052 of the California Water Code provides that the Regional Water Pollution Control Board shall formulate and adopt long-range plans and policies for the control of water pollution.

Despite rapid residential development in the San Lorenzo River Basin, which has occurred during the past decade there exists no community-wide sewerage system. Although plans have been formulated for such utility services, it is anticipated that small local systems will be forerunners of the more desirable overall system. Therefore, it is necessary that the Board adopt a policy aimed at defining appropriate uses of water in the area and establishing a criteria for protection of such uses. In this regard, the Water Pollution Control Board recognizes existing and planned water uses. It does not establish uses.

In accordance with the California Water Code, the Board has held public meetings and has caused investigations and reports to be made as preliminary steps in developing a water pollution control policy for the San Lorenzo River Basin.

Description of Area

The San Lorenzo River drains about 134 square miles of land, all lying in Santa Cruz County. The River discharges into Monterey Bay at Santa Cruz. In general, the drainage basin is steep, wooded hillside. Elevations vary from sea level to about 3,200 feet.

Residential development has occurred in much of the area; however, it is generally limited to the valley floor adjacent to the River and many of its principal tributaries and Scotts Valley. Numerous communities exist in the Basin, although none are incorporated.

The San Lorenzo River is utilized as a source of domestic water supply by the City of Santa Cruz. Water is removed from the stream at the northern limits of the City and processed in the municipal water treatment plant prior to distribution to the residents. Additional water supply is obtained by the City from a recently constructed reservoir on Newell Creek. Residents of the Valley obtain water from many tributaries to the San Lorenzo River and from ground water sources.

The River is used for recreational purposes, including water-contact sports, throughout the inhabited area of the Basin.

Principal tributaries include the following Creeks: Zayante, Bear, Two Bar, Newell, Love, Fall, Clear, Boulder, Kings, and Branciforte, the latter enters the San Lorenzo River just upstream from the point of discharge into Monterey Bay.

Precipitation in the watershed varies from approximately 28 inches average rainfall at Santa Cruz to over 50 inches at Boulder Creek. Rainfall is often intense. Flooding frequently occurs as a result of extreme storm conditions at various points in the watershed. Despite intensive rainfall and flooding, the streams of the Basin are characterized by having low flow volume during the Summer and early Fall.

Beneficial Water Uses

The Board recognizes the following beneficial uses of surface waters in the San Lorenzo River Basin:

1. Domestic water supply.

2. General recreational use and aesthetic enjoyment.

3. Water-contact sports.

4. Sportsfishing

5. Spawning and migration of sportsfish, habitat for many forms of aquatic life, including fish and the biological life (plant and animal) upon which they feed.

6. Ground water recharge.

7. Agricultural water supply, including irrigation and stock watering.

8. Boating (on water supply reservoirs).

9. Land drainage.

The Board recognizes that ground waters in the Basin constitute a source of domestic and industrial water supply.

The Board acknowledges that all uses indicated may not exist at present nor do they apply to all areas of the watershed.

Policy for Protection of Beneficial Uses

Since the San Lorenzo River and its tributaries constitute a principal domestic water supply source at all locations in the Basin. discharge directly to the River or its tributaries is not considered acceptable. Community waste disposal within the watershed is a recognized necessity. particularly in view of present and anticipated residential developments. With these factors in view, it is declared to be the policy of this Board to prevent waste discharges over which it has jurisdiction from creating conditions which would unreasonably impair these stated beneficial water uses.

In keeping with this policy. the Board makes the following determinations with respect to existing and planned domestic waste discharges:

1. In accordance with Section 13054.3 of the California Water Code, no direct discharge of wastes into the San Lorenzo River, its tributaries, or to domestic water supply reservoirs will be permitted.

2. Land disposal under suitable conditions is deemed a proper and acceptable method of sewage effluent disposal within the San Lorenzo River watershed. "Suitable conditions" shall be considered to include all of the following factors, which are associated with the land disposal of effluent:

    a. The discharge shall be maintained on designated land disposal area without overflow or bypass to other properties or drainageways at any time.

    b. There shall be no runoff from the land disposal area which contains detectable quantities of sewage effluent.

    c. Conclusive evidence shall be provided, prior to the time that treatment works are constructed and placed into operation, that sufficient land is available to provide disposal by percolation and evaporation. and that overflow will not occur under simulated operating conditions.

    d. Land disposal areas shall have isolation from residential developments to preclude public access and nuisance conditions from occurring which may affect adjacent properties.

    e. A bona fide responsible operating agency shall be available which is capable of maintaining and operating the proposed sewage treatment and disposal works.

3. Sewage treatment facilities which may be constructed shall include safeguards necessary to prevent any discharge to other than designated land disposal area and to prevent the discharge of improperly treated wastes to the disposal area. There shall be provisions for a standby power supply to operate essential units of the treatment and disposal facilities at all times.

4. Since it is contemplated that an overall sewerage system will ultimately be constructed which will remove wastes from the Basin for disposal, localized land disposal facilities are considered to be of an interim nature. Requirements for waste discharges shall provide that the local disposal systems are to be abandoned in favor of any available outfall system which will remove wastes from the San Lorenzo River Basin for disposal in the Pacific Ocean.

Objectives

When considering the establishment of requirements for specific waste discharges, the Board will be directed by the following objectives relevant to the particular discharge conditions:

1. Public Health. The Board shall take cognizance of public health hazards associated with waste discharges and require effective treatment and disposal for wastes which may contribute to such problems.

2. Aesthetic Considerations. All waste discharges shall be treated and controlled to preclude the appearance of objectionable matter in the disposal areas. Discharges shall not cause unsightliness due to sludge deposits or slime and fungus type growths in the disposal area. Discharges shall not cause odor nuisance in recreational, residential, or other areas readily accessible to the general public.

3. Toxic Substances and Mineral Constituents. No substance shall be present in the discharge in a concentration which would be deleterious to human, plant and animal life. Dissolved minerals shall not be present in the percolating wastes in concentrations which will render receiving waters unsuitable for recognized beneficial uses.

General Considerations

It shall be the Board's policy to encourage, wherever possible, the consolidation of sewerage systems. The advisability of locating two treatment plants in close proximity should be seriously questioned on the basis of capital investment and maintenance costs. From the standpoint of pollution control, it is not desirable, as experience has shown that frequently small plants do not receive the necessary maintenance or operation to consistently produce a high quality effluent.

When requirements are prescribed for a particular waste discharge in the area, the Board may prescribe a monitoring program to be carried out by the waste discharger. The monitoring program may include the following: provision for sampling and analyses of waste discharge and receiving area and submission of reports to the Board. Samples shall be analyzed for various bacteriological, chemical and physical characteristics. Location of sampling points and frequency of analyses shall be sufficient to insure compliance with the policy and requirements of the Board which apply to the particular discharge.

This policy statement shall be used by the Board as a guide when establishing requirements for waste discharges. However, requirements for each disposal will be determined on a case-by-case basis.

Should conditions of water use change materially, this policy statement and all requirements applicable to the area may be reviewed by the Board to determine if modifications are warranted to meet the changing needs of the area.

The Resources Agency of California
CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD
1108 Garden Street
San Luis Obispo, California

Adopted April 17, 1964

Requirements for Sewage Discharge
American Utilities, Inc. (Bear Creek Estates)

Report of American Utilities, Inc., 100 Forest Hill Drive, Boulder Creek, dated February 11, 1964, submitted in accordance with Section 13054, California Water Code, of a proposed enlargement of existing treatment and disposal facilities, has been considered by the Central Coastal Regional Water Pollution Control Board.

Proposal

1. Enlarge existing sewage treatment facilities to provide for additional units of Bear Creek Estates Subdivision, located about four miles northeasterly of Boulder Creek on Bear Creek Road. Additional facilities will be constructed at site of existing treatment plant, which is located within Subdivision No. 4 of Bear Creek Estates.

2. Treatment facilities to ultimately be enlarged to provide for 30,000 gallons per day average daily flow and will serve an estimated 110 single-family dwellings or equivalent at design capacity.

3. Dispose of effluent by means of spray irrigation on natural wooded hillside land owned or controlled by American Utilities, Inc.

4. Disposal area to be of sufficient size to maintain all effluent on land under the control of the discharger at all times.

Beneficial Uses

The Board recognizes the following beneficial uses of surface waters in Bear Creek and in the San Lorenzo River downstream from the confluence of Bear Creek.

1. Domestic water supply.

2. General recreational use and aesthetic enjoyment.

3. Water-contact sports.

4. Sportsfishing.

5. Spawning and migration of sportsfish, habitat for many forms of aquatic life, including fish and the biological life (plant and animal) upon which they feed.

6. Ground water recharge.

7. Agricultural water supply, including irrigation and stock watering.

8. Land drainage.

The Board recognizes that ground waters in the San Lorenzo River Basin constitute a source of domestic, industrial and agricultural water supply.

Objective

The Board wishes to reaffirm its action taken in December, 1962, with respect to sewage disposal in the San Lorenzo River Valley, i.e., " . . . there shall be no direct discharge of sewage effluent permitted to Bear Creek, the San Lorenzo River or its other tributaries." In adopting these requirements, it is the intent of the Board to prevent water pollution, to protect the public health and to prevent nuisance.

Requirements

The Board prescribes the following requirements for the discharge:

1. Treatment and disposal of the sewage shall not result in production of obnoxious odors in quantities sufficient to reach populated or recreational areas.

2. Mosquito and other insect breeding resulting from treatment and disposal of the sewage shall be controlled to the extent necessary to prevent a disease vector or nuisance problem from occurring.

3. The public shall have no contact with sewage effluent as a result of the disposal operations.

4. The discharge shall be maintained on the designated land disposal area without overflow or bypass to other properties or drainageways at any time.

5. There shall be no discharge of sewage effluent in detectable quantities permitted to Bear Creek or its tributaries at any time. Samples to determine detectability of sewage effluent shall be taken outside of the fenced spray disposal area.

6. The discharger shall construct a system incorporating features which provide capability of keeping all sewage effluent under control on land and preventing runoff of sewage effluent in detectable quantities at all times including times of rainfall.

7. No raw sewage shall be discharged to the land disposal area.

8. The B. O. D. concentration of the effluent as applied to the disposal area shall not average in excess of 30 milligrams per liter and shall not at any time exceed 50 milligrams per liter.

9. The suspended solids concentration of the effluent as applied to the disposal area shall not average in excess of 40 milligrams per liter and shall not at any time exceed 60 milligrams per liter.

10. Bypass of raw or treated sewage effluent directly to Bear Creek shall be considered a violation of these requirements.

11. Provision shall be made for auxiliary power supply at the treatment and pumping works to insure continuous functioning of mechanical equipment.

12. The discharger shall provide proof that adequate land disposal areas will be made available and dedicated for this purpose.

Reports

1. The discharger shall furnish technical reports as provided for in Section 13055 of the California Water Code on operation, discharge characteristics and receiving water quality. Such reports shall be submitted in accordance with specifications attached to these requirements, which specifications the staff of this Board is authorized to revise whenever necessary and such revision being subject to review by the Board at the request of the discharger.

2. Analyses of samples shall be in accordance with the latest edition of Standard Methods, published by the American Public Health Association.

Review of Requirements

Increase in average flows in excess of the design capacity stated hereinabove shall constitute a new discharge and must be officially reported to the Board. If, in the future, there are significant changes in conditions of the discharge or in use of the receiving area in the vicinity of the discharge, the Board will review its requirements and make modifications as may be necessary to protect beneficial uses.

Application of Requirements

1. Responsibility for compliance with all terms of these requirements shall rest with the discharger (American Utilities, Inc.) and the subdivider (Bear Creek Estates, Inc.).

2. Requirements adopted by the Central Coastal Regional Water Pollution Control Board for sewage discharge from Bear Creek Estates on 8-15-63 are hereby rescinded.

CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD
1108 Garden Street
San Luis Obispo, California

Adopted 2-24-6

Requirements for Proposed Discharge of Water Filtration Plant Wastes for American Utilities, Inc., Bear Creek, Santa Cruz County

Report of the American Utilities, Inc., dated January 12, 1961, submitted in compliance with Section 13054, California Water Code, of a proposed discharge of water filtration plant wastes, has been considered by the Central Coastal Regional Water Pollution Control Board.

Proposal

1. Bear Creek Estates, located on Bear Creek Road, about two miles northeast of Boulder Creek, Santa Cruz County, proposes a 500 home development (initial development consists of 40 residential lots).

2. Water service to the community will be furnished by the American Utilities, Inc., and will be obtained by diverting water from Bear Creek in Section 31, T. 9 S., R. 2 W., M. D. B. & M.

3. American Utilities proposes to discharge, after settling for removal of bulk of spent filter-aid, diatomaceous earth filter backwash water, amounting to about 200 gallons per day to the Creek, a short distance below the point of diversion.

Beneficial Uses

Beneficial uses of waters downstream from the proposed discharge include:

1. Year around use for domestic water supply.

2. Sportsfishing.

3. Aesthetic enjoyment and scenic attractiveness.

4. Habitat for sportsfish and aquatic life, including fish sperming and migration.

5. Recreation, including swimming and boating.

Objective

It shall be the objective of the Board to protect beneficial uses and to prevent pollution or nuisance.

Requirements

1. The discharge shall not result in an increase of natural stream turbidity of more than three turbidity units or 10% whichever is the greater.

2. The discharge shall be controlled so that settleable solids do not create nuisance from unsightliness or adversely affect fish and aquatic life.

Review of Requirements

These requirements are adopted with the understanding that substantially all spent filter-aid will be removed prior to discharge of wash water and that disposal of the spent filter-aid will be by means other than discharge to Bear Creek. Should it be found that these materials are entering the discharge in such quantities that an unreasonable effect on beneficial uses is threatened, the Board will review conditions of the discharge and take appropriate action.

The Resources Agency of California
CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD
1108 Garden Street
San Luis Obispo, California

Adopted July 10, 1964

Requirements for Sewage Discharge from Big Basin Wood, Santa Cruz County

Report of Big Basin Sanitation Company, Boulder Creek, dated March 26, 1964, submitted in accordance with Section 13054, California Water Code, of a proposed sewage discharge has been considered by the Central Coastal Regional Water Pollution Control Board.

Proposal

1. Construct sewage treatment facilities to serve the Big Basin Woods Subdivision, located in Sec. 14, T. 9 S., R. 3 W., M. D. B. & M., Santa Cruz County, near State Highway 44A and Jamison Creek Road. The treatment facilities will be constructed within said Subdivision and will serve an estimated population of 350 persons.

2. Treatment facilities to receive an estimated 35,000 gallons per day from the proposed subdivision.

3. Dispose of effluent by means of sub-surface percolation on approximately 2-1/2 acres of land owned by Big Basin Woods Subdivision.

4. Disposal area to be of sufficient size to maintain all effluent on land under the control of the discharger at all times.

5. The entire sewage disposal system will be maintained and operated by Big Basin Sanitation Company, a subsidiary of the Big Basin Water Company.

Beneficial Uses

The Board recognizes the following beneficial uses of surface waters in Jamison Creek, Boulder Creek, and in the San Lorenzo River downstream from the confluence of Jamison Creek:

1. Domestic water supply.

2. General recreational use and aesthetic enjoyment.

3. Water-contact sports.

4. Sportsfishing.

5. Spawning and migration of sportsfish, habitat for many forms of aquatic life, including fish and the biological life (plant and animal) upon which they feed.

6. Ground water recharge.

7. Agricultural water supply, including irrigation and stock watering.

8. Land drainage.

The Board recognizes that ground waters in the San Lorenzo River Basin constitute a source of domestic, industrial and agricultural water supply.

Objective

The Board wishes to reaffirm its Policy Statement adopted October 31, 1963, with respect to sewage disposal in the San Lorenzo River Valley, i. e., " . . . no direct discharge of wastes into San Lorenzo River, its tributaries or to domestic water supply reservoirs will be permitted." In adopting these requirements, it is the intent of the Board to prevent water pollution, to protect the public health and to prevent nuisance.

Requirements

The Board prescribes the following requirements for the discharge:

1. Treatment and disposal of the sewage shall not result in production of obnoxious odors in quantities sufficient to reach populated or recreational areas.

2. Mosquito and other insect breeding resulting from treatment and disposal of the sewage shall be controlled to the extent necessary to prevent a disease vector or nuisance problem from occurring.

3. The public shall have no contact with sewage effluent as a result of the disposal operations.

4. The discharge shall be maintained on the designated land disposal area without overflow or bypass to other properties or drainageways at any time.

5. There shall be no discharge of sewage effluent in detectable quantities permitted to Boulder Creek or its tributaries at any time.

6. The discharger shall construct a system incorporating features which provide capability of keeping all sewage effluent under control in sub-surface disposal system and preventing runoff of sewage effluent in detectable quantities at all times including times of rainfall.

7. No raw sewage shall be discharged to the land disposal area.

8. The discharger shall determine the best system for disposal of the design flow. Tests shall be made using fresh water rather than sewage effluent.

9. Bypass of raw or treated sewage effluent directly to Boulder Creek shall be considered a violation of these requirements.

10. Provision shall be made for auxiliary power supply at the treatment and pumping works to insure continuous functioning of necessary mechanical equipment.

11. The discharger shall execute agreements which may be necessary with an operating company or County Public Works Agency to assure effective and continuous operation and maintenance.

Reports

1. The discharger shall furnish technical reports as provided for in Section 13055 of the California Water Code on operation, discharge characteristics and receiving water quality.

2. Analyses of samples shall be in accordance with the latest edition of Standard Methods, published by the American Public Health Association.

Review of Requirements

Any plan to increase the area to be served by the treatment plant as described hereinabove shall constitute a new discharge and must be officially reported to the Board. If, in the future, there are significant changes in conditions of the discharge or in use of the receiving area in the vicinity of the discharge, the Board will review its requirements and make modifications as may be necessary to protect beneficial uses.

Application of Requirements

1. Responsibility for compliance with all terms of these requirements shall rest with the discharger and the subdivider.

2. These requirements apply only for the disposal of effluent by subsurface leaching system. Disposal by any other means shall constitute a new discharge and must be reported to the Board.

The Resources Agency of California
REGIONAL WATER POLLUTION CONTROL BOARD
1108 Garden Street
San Luis Obispo, California

Adopted 10-2-64

Requirements for Waste Discharge from Central Supply Company, Santa Cruz County

Pursuant to authority of Section 13053 of the California Water Code, the Central Coastal Regional Water Pollution Control Board has investigated and considered the effects of waste discharges from the operations of the Central Supply Company, which industry is producing graded sand products at a location in the San Lorenzo River Valley, near Zayante, Santa Cruz County.

Waste Discharge Conditions

Waste discharges considered in these requirements include runoff of storm waters from properties owned and/or controlled by Central Supply Company which are subject to erosion during and following rainstorms. Specifically, the waste discharge problem involves deposition of sandy material in Azalea Dell Creek during storm runoff. Subsequent transportation into Zayante Creek of such deposited material by normal stream flow results in an unreasonable alteration of natural conditions of the stream bottom. Normal operation of the Sand Plant does not provide for discharge of process wash waters.

Beneficial Uses

Beneficial uses made of Zayante Creek and the San Lorenzo River below the confluence of Zayante Creek include:

1. Year-around use for domestic water supply.
2. Sportsfishing.
3. Aesthetic enjoyment.
4. Scenic attractiveness.
5. Rearing, spawning and habitat for sportfish and aquatic life.
6. Swimming and boating.
7. Agricultural and yard irrigation.

It is noted that during certain periods of the year, the above beneficial uses are abridged by the natural runoff characteristics of the stream and watershed. Runoff during and immediately following periods of rainstorm carries with it large quantities of silt and soil. During such occasions, the stream is unsuitable for the above-mentioned uses.

Requirements

In order to protect the above-mentioned beneficial uses, the Board prescribes the following requirements for the waste discharge from the Central Supply Company Plant and properties:

1. Discharge of storm runoff waters shall be controlled so that sand and silt will not be deposited in Azalea Dell or Zayante Creek in quantities that materially alter conditions on the stream bottom.

2. The sand plant operations shall be conducted so that quarried sand, graded sand, overburden, or other material resulting from the operations is not placed in or adjacent to Azalea Dell Creek where it will be subject to erosion by waters flowing in the stream.

As part of the Board's monitoring program, the sand plant will be required to furnish technical reports as provided in Section 13055 of the California Water Code on operation, discharge characteristics and receiving water quality.

REGIONAL WATER POLLUTION CONTROL BOARD

CENTRAL COASTAL REGION

1108 Garden Street

San Luis Obispo, California

July 22, 1960

Citizens Utilities Company of California
Box H
Boulder Creek, California

Gentlemen:

Requirements for Water Quality Conditions to be Maintained in Fall Creek, Santa Cruz County Downstream from Citizens Utilities Company Reservoir

Pursuant to authority of Section 13055 of the California Water Code, the Central Coastal Regional Water Pollution Control Board has investigated and considered the effects that fine-grained materials resulting from erosion of the Citizens Utilities Company of California reservoir, located near Boulder Creek, Santa Cruz County, are having on the quality of waters in Fall Creek and Boulder Creek.

The reservoir in question is located on a ridge between Fall Creek (sometimes known as Hesse Brook) and Forman Creek, tributaries to Boulder Creek, in Section 25, T. 9 S., R. 3 W.

Based on information developed by investigations undertaken by the Board and from statements made at a regular meeting of the Board held March 25, 1960, in Paso Robles, the Board finds:

1. Beneficial uses made of Fall Creek include:

    a. Year-around source of domestic water supply for three properties, including one property which has several rental units.

    b. Year-around source of water supply for a commercial trout farm.

2. Beneficial uses of Boulder Creek include:

    a. Fish propagation, migration route for spawning of steelhead and sportsfishing.

    b. Scenic attractiveness and aesthetic enjoyment.

    c. Recreation, including swimming.

3. Quality of waters in Fall Creek and Boulder Creek for the above-stated uses has been adversely and unreasonably affected by fine-grained materials eroded or washed from the exterior face of said Citizens Utilities Company reservoir during periods of rainfall and runoff. A continuing, adverse and unreasonable effect is threatened.

By authority vested in the Board by Section 13053 of the California Water Code, the Board prescribes the following requirements for the quality of water in Fall Creek at the upper water supply intake, used by Peter J. Horvath, which is located several hundred feet upstream from the Big Basin Highway.

1. Creek waters shall not, at any time, as the result of erosion from the Citizens Utilities Company reservoir, its access road or its construction area, be increased as the result of fine-grained materials by more than:

   a. 40 color units (true color).

   b. 20 turbidity units.

   c. 5 ml/l settleable solids.

2. Analyses of samples shall be in accordance with the latest edition of Standard Methods for the Examination of Water, Sewage, and Industrial Wastes, published by the American Public Health Association, except that the settleable solids determination may be made after one-quarter (1/4) hour of settling.

The Citizens Utilities Company shall be responsible for taking whatever measures are necessary to arrest the erosion of fine-grained materials from the reservoir area and thus prevent these requirements from being exceeded.

Very truly yours,

CENTRAL COASTAL REGIONAL WATER
POLLUTION CONTROL BOARD

By________________________
RAYMOND WALSH
Executive Officer

cc: State Water Pollution Control Board.
Department of Water Resources (Sacramento and Los Angeles).
Department of Fish and Game (San Francisco and Sacramento).
Bureau of Sanitary Engineering.
Santa Cruz County Health Department.
Mr. Peter J. Horvath.

REGIONAL WATER POLLUTION CONTROL BOARD
CENTRAL COASTAL REGION

1108 Garden Street

San Luis Obispo, California

October 3, 1956

Mrs. Rosannah Kerr, General Delivery, Ben Lomond, California.
Mr. Bruno Grossman, Scotts Valley, Santa Cruz, California.
Mr. Donald D. Benjamin, 148 Plateau Drive, Felton, California.
Mr. John Davis, Box 139, Felton, California.

Dear Madam and Gentlemen:

Requirements for Water Quality Conditions
to be Maintained in South Fork of Marshall Creek
(tributary to San Lorenzo River), Santa Cruz County

Pursuant to authority of Section 13055 of the California Water Code, the Central Coastal Regional Water Pollution Control Board has investigated and considered the effects wastes resulting from logging operations undertaken on property owned by Mrs. Rosannah Kerr are having on the quality of the South Fork of Marshall Creek, Santa Cruz County.

Based upon information developed by investigations undertaken by the Board and public meetings held in Santa Cruz on June 15, 1956, and September 28, 1956, the Board finds that:

1. The drainage, flow, or seepage into waters of the State of harmful concentrations of material as the result of logging operations constitutes the discharge of waste over which a Regional Water Pollution Control Board has jurisdiction.

2. Beneficial uses made of the South Fork of Marshall Creek include the year-around source of domestic water supply for Lawrence Rawson and the Mountain Springs Water Service, which serves approximately twelve families. The Creek also serves as a stand-by source of domestic water supply for the Citizens Utilities Company, which serves the community of Ben Lomond. The Creek is tributary to the San Lorenzo River--the waters of which are used for additional beneficial uses.

3. Quality of water in the South Fork of Marshall Creek for the above stated uses has been adversely and unreasonable affected by wastes resulting from logging operations and a continuing adverse and unreasonable effect is threatened.

By authority vested in the Board by Section 13053 of the California Water Code, the Board prescribes the following requirements for the quality of the water in the South Fork of Marshall Creek at the Mountain Springs Water Service diversion: Creek waters shall not at any time be increased as the result of logging operations, including road construction in the performance of this undertaking, on the Rosannah Kerr property by more than 40 ppm Color (cobalt scale) and/or 20 ppm Turbidity (silica scale). For determining compliance with those requirements, samples of Creek waters will be collected upstream from the logging area to determine natural stream conditions at the same time samples are collected at the Mountain Springs Water Service diversion.

You are advised this action by the Board is in no way a limitation on the right of any person to maintain at any time any appropriate action for relief against any private nuisance as defined in the Civil Code or for relief against any contamination or pollution.

Very truly yours,

CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD

By____________________________
PAUL R. BONDERSON
Executive Officer

cc: State Water Pollution Control Board
Mr. B. A. Goldberg, Deputy Attorney General
Mrs. Alice Wilder
Mr. Lawrence Rawson
Citizens Utilities Company
Santa Cruz County Planning Commission
Santa Cruz County Board of Supervisors
State Department of Water Resources
Bureau of Sanitary Engineering
State Department of Fish and Game (San Francisco and Sacramento)
Central Coast Timber Operators Association
Sec'y-Mgr., California Forest Protective Association
Santa Cruz County District Attorney
Attorney John E. Nicholson
Santa Cruz County Health Department
Division of Forestry (Monterey and Sacramento)

The Resources Agency of California
CENTRAL COASTAL REGIONAL WATER POLLUTION CONTROL BOARD
1108 Garden Street
San Luis Obispo, California

Adopted July 10, 1965

Requirements for Sewage Discharge
from Rolling Woods Subdivision, Santa Cruz County

Report of Rolling Woods Utilities, Inc., dated April 17, 1964, submitted in accordance with Section 13054, California Water Code, of a proposed sewage discharge has been considered by the Central Coastal Regional Water Pollution Control Board.

Proposal

1. Construct sewage treatment facilities to serve the Rolling Woods Subdivision, located in Tract No. 420, Rolling Woods Subdivision No. 5, Santa Cruz County, on Graham Hill Road near the southeast corner of Henry Cowell Redwoods State Park. The treatment facilities will be constructed within said Subdivision and will serve an estimated population of 94 person.

2. Treatment facilities to receive an estimated 11,000 gallons per day from the proposed subdivision. Treatment plant to be constructed on a lot near the southwest corner of the Subdivision at an approximate elevation of 480 feet. Effluent is to be pumped to the north side of the tract for disposal on portions of Lots 8 and 9 in the Subdivision at an approximate elevation of 540 feet.

3. Dispose of effluent by means of sub-surface percolation pits on land owned or controlled by Rolling Woods Subdivision.

4. Disposal area to be of sufficient size to maintain all effluent on land under the control of the discharger at all times.

5. The entire sewage disposal system will be maintained and operated by Rolling Woods Utilities, Inc., a California Corporation.

Beneficial Uses

The Board recognizes the following beneficial uses of surface waters which may flow in the unnamed drainage channel leaving the property and discharging across State Park lands into the San Lorenzo River and in the San Lorenzo River downstream from the confluence with said drainage channel:

1. Domestic water supply.

2. General recreational use and aesthetic enjoyment.

3. Water-contact sports.

4. Sportsfishing.

5. Migration of sportsfish, habitat for many forms of aquatic life, including fish and the biological life (plant and animal) upon which they feed.

6. Ground water recharge.

7. Agricultural water supply, including irrigation and stock watering.

8. Land drainage.

The Board recognizes that ground waters in the San Lorenzo River Basin constitute a source of domestic, industrial and agricultural water supply.

Objective

The Board wishes to reaffirm its Policy Statement adopted October 31, 1963 with respect to sewage disposal in the San Lorenzo River Valley, i.e., " . . . no direct discharge of wastes into San Lorenzo River, its tributaries, or to domestic water supply reservoirs will be permitted." In adopting these requirements, it is the intent of the Board to prevent water pollution, to protect the public health and to prevent nuisance.

Requirements

The Board prescribes the following requiremtns for the discharge:

1. Treatment and disposal of the sewage shall not result in production of obnoxious odors in quantities sufficient to reach populated or recreational areas.

2. Mosquito and other insect breeding resulting from treatment and disposal of the sewage shall be controlled to the extent necessary to prevent a disease vector or nuisance problem from occurring.

3. The public shall have no contact with sewage effluent as a result of disposal operations.

4. The discharge shall be maintained on the designated land disposal area without overflow or bypass to other properties or drainageways at any time.

5. There shall be no discharge of sewage effluent in detectable quantities permitted to tributaries of the San Lorenzo River at any time.

6. The discharger shall construct a system incorporating features which provide capability of keeping all sewage effluent under

control in sub-surface disposal system and preventing runoff of sewage effluent in detectable quantities at all times including times of rainfall.

7. No raw sewage shall be discharged to the land disposal area.

8. The discharger shall determine the best system for disposal of the design flow. Tests shall be made using fresh water rather than sewage effluent.

9. Bypass of raw or treated sewage effluent directly to adjacent drainageway shall be considered a violation of these requirements.

10. Provision shall be made for auxiliary power supply at the treatment and pumping works to insure continuous functioning of necessary mechanical equipment.

11. The discharger shall execute agreements which may be necessary with an operating company or County Public Works Agency to assure effective and continuous operation and maintenance.

12. The discharger shall provide proof that adequate land disposal areas will be made available and dedicated for this purpose.

Reports

1. The discharger shall furnish technical reports as provided for in Section 13055 of the California Water Code on operation, discharge characteristics and receiving water quality.

2. Analyses of samples shall be in accordance with the latest edition of Standard Methods, published by the American Public Health Association.

Review of Requirements

Any plan to increase the area to be served by the treatment plant as described hereinabove shall constitute a new discharge and must be officially reported to the Board. If, in the future, there are significant changes in conditions of the discharge or in use of the receiving area in the vicinity of the discharge, the Board will review its requirements and make modifications as may be necessary to protect beneficial uses.

Application of Requirements

1. Responsibility for compliance with all terms of these requirements shall rest with the discharger and the subdivider.

2. These requirements apply only for the disposal of effluent by sub-surface leaching system. Disposal by any other means shall constitute a new discharge and must be reported to the Board.

BEAR CREEK REVISITED

A

REPORT TO THE
STATE WATER QUALITY CONTROL BOARD

BY

RAYMOND WALSH

EXECUTIVE OFFICER
CENTRAL COASTAL REGIONAL
WATER POLLUTION CONTROL BOARD

August 1965

BEAR CREEK REVISITED

INTRODUCTION

Bear Creek Estates, a small subdivision in Santa Cruz County with its own complete sewerage system, created considerable interest at the Regional Board and State Board level in 1963 and again in 1964. Action of the Regional Board to adopt requirements was appealed two times to the State Board. In the first instance, the State Board referred the requirements back to the Regional Board for suggested modifications. In the second instance, the State Board found no justification for review. In both proceedings, questions were raised by those opposing the Regional Board action concerning the efficacy of the sewerage system. This report briefly describes conditions that have been found.

Chapter I. Yesterday

1962

1. Bear Creek Estates Subdivision, San Lorenzo Valley, Santa Cruz County, consisting of a 34-lot single family residential development, files report with Regional Board to discharge treated sewage effluent to Bear Creek. Bear Creek is a tributary to the San Lorenzo River, which is an extensively developed recreational area. In addition to recreational use of the river, the City of Santa Cruz obtains a portion of its water supply by direct diversion from the river at the lowest point in the drainage basin.

2. The Central Coastal Regional Water Pollution Control Board, at its December meeting, took action to prohibit direct discharge of sewage effluent to Bear Creek from the Bear Creek Estates Subdivision.

1963

1. Bear Creek Estates Subdivision files revised report with Regional Board to discharge effluent from 34-lot subdivision to land disposal area adjoining the tract. Actual disposal to be by spray irrigation of naturally wooded hillside.

2. Regional Board establishes requirements for land disposal, with provision that there be no overflow or bypass to other properties or drainageways. In its requirements, the Board noted that during periods of heavy rainfall, some effluent could be carried off the land disposal area with natural runoff.

3. The State and County Departments of Public Health oppose any discharge and recommended that the Regional Board take action which would prohibit use of a community sewerage system for the subdivision. The San Lorenzo Valley Chamber of Commerce expressed to the Board its strong opposition to the proposed discharge.

4. Following adoption of requirements, the San Lorenzo Valley Chamber of Commerce appealed the Regional Board action to the State Board.

5. After a field trip to the Bear Creek Estates Subdivision, the State Board held a meeting to consider whether the Regional Board had failed to take or obtain appropriate action. The State Board referred the subject back to the Regional Board, with the recommendation that it give consideration to the recommendation made by the State Department of Public Health to the State Board.

6. The Regional Board revised its requirements, incorporating into them the recommendations of the State Department of Public Health. The revised requirements deleted reference to wintertime operation and provided that no sewage effluent in detectable quantities would be permitted outside the designated land disposal area.

7. The State Board found the Regional Board had taken appropriate action.

8. Bear Creek Estates Subdivision starts construction. Six residences completed by end of the year.

<u>1964</u>

1. Bear Creek Estates Subdivision plans additional units and files report with Regional Board.

2. County Health Department opposes additional development until facilities have been proven satisfactory at full development of original subdivision. San Lorenzo Valley Chamber of Commerce indicates to Board its opposition to additional development.

3. Regional Board revises requirements to provide for additional flow (estimated 30,000 gallons per day at ultimate development of all units).

4. San Lorenzo Valley Chamber of Commerce appeals Regional Board action to State Board.

5. State Board finds Regional Board has taken appropriate action and no justification for State Board to review the requirements.

Chapter II. Today

Subdivision

A total of sixty sewered lots have been developed. Thirty-nine homes are completed or are under construction (some of which are speculative and model homes that have not been sold). Of the remaining 21 vacant lots, 10 have been sold.

A modern, well landscaped, clearly identified sewage treatment plant has been constructed. The plant is located on a corner lot at the entrance to the subdivision. On the adjoining lot less than 50 feet away is a $30,000 home. There is a standby power supply and safeguards have been provided to minimize the possibility of accidental overflow to Bear Creek. Treatment facilities now installed are designed to handle 10,000 gallons per day of sewage and are capable of producing an effluent that complies with the Board's requirements. If care is given to operation, the facilities can provide treatment without production of unpleasant odors.

Disposal of effluent is by spray irrigation of naturally wooded hillside. The presently installed system includes twelve sprinklers which are used alternately in two groups. If needed, additional sprinklers can be provided as pumps and pipes have capacity for ultimate flows and only a portion of the land disposal area is being used. The disposal area is fairly well isolated by natural conditions, namely, a steep hill. It is screened from sight from the subdivision by trees and brush. The disposal area is not fenced or posted.

In accordance with conditions of the Board's requirements, the discharger submits annual reports on volume of sewage flow and suspended solids in the discharge. Records concerning operation of the treatment and disposal facilities are maintained for inspection by the Board. Total sewage flow reported for calendar year 1964 was 645,500 gallons. The monthly average of flow was 2,840 gallons per day for September, the peak month. The peak month during 1965 was April, with average flow of 3,370 gallons per day.

Regional Board

The Board's staff has maintained close surveillance of the treatment and disposal operations since inception of the project. An inspection of the treatment facilities and land disposal area has been conducted on the average of every other month during the rainfall season -- October to April inclusive. Inspection of the treatment facilities includes observation of physical appearance and general operation. Operating logs and report forms are reviewed. Samples of effluent are collected annually for analysis in the laboratory to determine suspended solids and bio-chemical oxygen demand. A field determination of settleable solids is made at the time samples are collected for laboratory analysis. Inspection of the disposal area includes the following observations:

1. Comparison of areas that are receiving effluent with adjacent ground that is not receiving effluent, for changes in physical appearance, forest litter, vegetation, erosion, and soil compaction.

2. Evidence of runoff or other movement of applied water from disposal area, shallow excavations are made on hillside below the disposal area from time to time to detect runoff.

3. Evidence of seepage at the base of the hill below the disposal area.

During all inspections made to date, the following conditions have been observed:

1. Treatment facilities have been operating satisfactorily.

2. Testing and operating records by discharger are in compliance with Board's requirements.

3. No evidence of bypass of raw sewage to disposal area or discharge of any kind to Bear Creek.

4. Treatment facilities and disposal area have been operating without creation of nuisance conditions.

5. Some change in appearance has been noted in vegetation in areas sprayed compared with areas not sprayed. In areas sprayed with effluent, defoliation has been noted in the shaded portions and luxuriant grass growth noted in the sunny portions.

6. Forest litter does not appear to be materially changed by spraying.

7. No evidence found of movement of applied effluent downhill from disposal area.

8. On only one inspection, April 1965, has there been a continuous flow observed in the natural drainageway at the base of the hill below the disposal area. This inspection was made two days after a four day period of heavy rainfall when more than seven inches of rain was recorded at Boulder Creek. Flow was estimated at not more than one or two gallons per minute. There was no noticeable increase in volume as it passed the tributary area of the disposal site. From appearance and smell, the flow had no characteristic of sewage. A methylene blue test for detergents made on a sample collected below the tributary area of the disposal site was negative for detergent material. The flow ceased a few days later.

On several occasions, inspections have been made a few days to a week after heavy rainfall and no continuous flow has been observed in this drainageway. The rainfall this year (1964-65) at Boulder Creek has been 68 inches. Normal twenty year average is 55 inches. Last year (1963-64), there were 35 inches of rain recorded at Boulder Creek.

County Health Department

The Santa Cruz County Health Department has made inspections of the treatment and disposal facilities from time to time. No objectionable conditions have been observed. The Department is aware that no measures have been taken to exclude the public from the disposal area. However, no particular access problem is apparent at this time. The Department notes that existing facilities have not been loaded to design capacity, which, when it occurs, will be the real test of the effectiveness of the treatment and disposal system.

Chapter III. Tomorrow

Subdivision

More homes will be constructed, although development of additional sewered lots is not anticipated for the next year or so. The developer has assured the Board that when additional treatment and disposal facilities are needed, they will be provided. Here again, current rate of development does not indicate that additional facilities will be needed for the next few years. Consideration is being given by the developer to fencing and posting the disposal area.

Regional Board

The Regional Board will continue its close surveillance of the treatment and disposal facilities until it is conclusively established that the system can operate effectively under all conditions without creating pollution, nuisance or health problems. During the coming year, there will be at least one inspection every other month during the rainy season. There will be provision to collect samples of water in the natural drainageway at the base of the hill below the disposal area and analyze it to determine if there is sewage in detectable quantities.

The Regional Board has considered and adopted requirements for several other proposals for sewerage systems to serve small residential subdivisions in the San Lorenzo Valley. Although those that have been built to date have provided subsurface leaching as a means of final effluent disposal, it is expected that, in due time, there will be additional proposals for final disposal by spray irrigation.

Summary

The sewerage system serving Bear Creek Estates has now been operating nearly two years. Frequent inspections by the Regional Board staff have found on all occasions that the disposal system is operating without runoff or seepage outside the designated disposal area.

Even during a winter of higher than normal rainfall, the effluent disposal system did not completely saturate the soil.

No odors or unsightliness as a result of the treatment and disposal operations have been observed by the Board's staff. Furthermore, no complaint of such conditions has been made to the Board or the Santa Cruz County Health Department.

Due to the interest in this system and to the interest in possible future installations of this type in the same county, the Regional Board will continue its close surveillance.

APPENDIX C

WATER QUALITY ANALYSES

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo River near Waterman Switch (Sta. 1)

8S/3W-25L

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/29/63 0725	1	55			552	8.1 / 8.3	86 / 4.29	9.0 / 0.74	23 / 1.00	1.7 / 0.04	0 / 0.00	258 / 4.23	64 / 1.33	14 / 0.39	1.4 / 0.02	0.4 / 0.02	0.17	24	PO_4 0.54; ABS 0.0	357[c]	16	252	40		
10/7/63 1220	1	57	9.8	94	552	8.0 / 8.2	5.00[a]		24 / 1.04		0 / 0.00	261 / 4.28		13 / 0.37	0.8 / 0.01				PO_4 0.66; Fe 0.03	355[d]		250			
11/6/63 1500	4	51	10.0	90	444	8.4 / 8.0	3.84[a]		18 / 0.78		0 / 0.00	184 / 3.02		12 / 0.34	0.7 / 0.01				PO_4 0.51; Fe 0.02; ABS 0.0; Mn 0.00; SS 42	285[d]		192			
12/10/63 0915	2	41	11.3	88	534	7.9									0.0 / 0.00				PO_4 0.39	345[d]					
1/14/64 0905	1-1/2	40	12.0	92	550	8.0 / 8.2	4.92[a]				0 / 0.00	250 / 4.10		15 / 0.42	0.4 / 0.01				PO_4 0.50	355[d]		246			
2/19/64 0840	2	45			536	7.5 / 8.1	4.76[a]				0 / 0.00	235 / 3.85		16 / 0.45	0.2 / 0.00				PO_4 0.45; C=0	345[d]		238			
3/24/64 0930	3	42	12.0	95	493	8.1 / 8.0	4.30[a]				0 / 0.00	204 / 3.34		15 / 0.42	1.0 / 0.02				PO_4 0.48; SS 36	320[d]		215		40	
4/21/64 0930	2	47	11.6	98	549	8.4 / 8.1	4.86[a]				0 / 0.00	252 / 4.13		16 / 0.45	1.2 / 0.02				PO_4 0.49; Fe 0.03	355[d]		243		3.2	
5/12/64 0910	1	50	10.2	90	559	8.3 / 8.3	4.98[a]				2 / 0.07	254 / 4.16		16 / 0.45	0.4 / 0.01				PO_4 0.55	360[d]		249		1.3	
6/25/64 0755	1.5	59	8.9	88	562	7.8 / 8.4	4.98[a]		24 / 1.04		2 / 0.07	258 / 4.23		15 / 0.42	1.8 / 0.03				PO_4 0.58	360[d]		249		1.5	
7/21/64 0730	1	56	8.1	77	564	7.5 / 8.7	5.07[a]				16 / 0.53	237 / 3.88		15 / 0.42	0.0 / 0.00				PO_4 0.58	365[d]		254		0.6	
8/18/64 1315	3/4	62	9.7	99	564	8.2								14 / 0.39	0.4 / 0.01				PO_4 0.64; ABS 0.0	365[d]				0.1	
9/23/64	1/2	55	9.1	86	573	8.0	4.98[a]							9.3 / 0.26	1.1 / 0.02				PO_4 0.70	370[d]		249		1.5	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Kings Creek (Sta. 5)
9S/2W-18D

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/29/63 0755	1	59			627	7.6	74 / 3.69	15 / 1.27	38 / 1.65	2.3 / 0.06	0 / 0.00	218 / 3.57	101 / 2.10	31 / 0.87	1.6 / 0.03	0.5 / 0.03	0.27	21	PO_4 0.28, Fe 0.10; ABS 0.0, C=10	407[c]	25	248	69		
10/7/63 1320	1/2	60	9.6	96	659	8.1 / 8.1	5.03[a]		44 / 1.91		0 / 0.00	231 / 3.79		36 / 1.02	0.6 / 0.01				PO_4 0.31, Fe 0.11	425[d]		252			
11/7/63 0845	2	47	10.7	90.8	570	7.8 / 8.0	4.44[a]		30 / 1.30		0 / 0.00	168 / 2.75		26 / 0.73	0.5 / 0.01		0.2		PO_4 0.32, Fe 0.03; ABS 0.0	370[d]		222			
12/10/63 0935	1	39	12.0	91	613	7.7														400[d]					
1/14/64 0930	1/2	35	13.0	93	667	7.8 / 8.2	5.21[a]				0 / 0.00	215 / 3.52		30 / 0.85	0.8 / 0.01				PO_4 0.21	430[d]		261			
3/24/64 0940	2	44	12.3	100	553	7.8 / 8.0	4.30[a]				0 / 0.00	171 / 2.80		24 / 0.68	0.3 / 0.00				PO_4 0.19	360[d]		215		3.2	
4/21/64 1000	3/4	49	12.6	110	659	8.0 / 8.1	5.07[a]				0 / 0.00	212 / 3.47		32 / 0.90	0.1 / 0.00				PO_4 0.24	425[d]		254		2.7	
5/12/64 0945	1/2	52	10.0	91	674	7.8 / 8.2	5.13[a]				0 / 0.00	219 / 3.59		34 / 0.96	0.0 / 0.00				PO_4 0.26	435[d]		257		1.2	
6/25/64 0840	1/2	62	7.9	81	698	7.9 / 8.1	5.25[a]		44 / 1.91		0 / 0.00	233 / 3.82		40 / 1.13	1.0 / 0.02				PO_4 0.01	455[d]		263		2.5	
7/21/64 0815	1/2	60	8.0	80	760	7.3 / 8.2	5.53[a]				0 / 0.00	242 / 3.97		47 / 1.32	0.0 / 0.00				PO_4 0.27	490[d]		277		1.2	
8/18/64 1250	< 1/10	68	8.0	87	829	7.3								54 / 1.52	0.2 / 0.00				PO_4 0.32; ABS 0.0						
9/23/64 0830	1/5	53	7.1	65	864	7.7	5.83[a]							29 / 0.82	1.5 / 0.02				PO_4 0.46	560[d]		292		3.8	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves.

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Two Bar Creek (Sta. 6)
9S/2W-18N

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen % Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/29/63 0820	1/4	55			579	7.4 / 7.9	52 / 2.59	12 / 0.97	48 / 2.09	2.9 / 0.07	0 / 0.00	157 / 2.57	104 / 2.16	35 / 0.99	0.7 / 0.01	0.4 / 0.02	0.18	25	PO_4 0.19, Fe 0.24; ABS 0.0, C=15	368[c]	36	178	49		
10/7/63 1430	1/10	57	7.6	73	640	7.3 / 8.0	3.84[a]		60 / 2.61		0 / 0.00	182 / 2.98		40 / 1.13	0.7 / 0.01				PO_4 0.23, Fe 0.26	405[d]		192			
11/7/63 0915	1/2	48	10.3	89	539	7.6 / 8.0	3.52[a]		40 / 1.74		0 / 0.00	126 / 2.06		29 / 0.82	0.2 / 0.00		0.1		PO_4 0.23, FE 0.18; ABS 0.0	340[d]		176			
12/10/63 1000	1/2	41	11.5	90	505	7.4														320[d]					
1/14/64 0955	1/4	38	11.8	88	548	7.5														350[d]					
3/24/64 1015	1/2	44	11.7	95	463	7.3 / 7.6	2.94[a]				0 / 0.00	104 / 1.70		23 / 0.65	0.8 / 0.01				PO_4 0.14	295[d]		147		28	
4/21/64 1030	1/4	47	11.1	94	563	7.7 / 7.9	3.62[a]				0 / 0.00	147 / 2.41		30 / 0.85	0.3 / 0.00				PO_4 0.14	360[d]		181		4.2	
5/12/64 1010	< 1/4	52	9.9	90	592	7.7 / 8.1	3.76[a]				0 / 0.00	160 / 2.62		32 / 0.90	0.3 / 0.00				PO_4 0.17	375[d]		188		2.8	
7/21/64 0850	< 1/4	67	8.1	87	640	7.3 / 8.2	3.86[a]				0 / 0.00	190 / 3.11		42 / 1.18	0.5 / 0.01				PO_4 0.25	405[d]		193		0.9	
8/18/64 1230	< 1/8	65	8.1	86	684	7.9								47 / 1.32	1.6 / 0.02				PO_4 0.27; ABS 0.0	435[d]				2.1	
9/23/64 0855	< 1/8	54	6.7	62	718	7.6	4.08[a]							26 / 0.73	1.2 / 0.02				PO_4 0.32	455[d]		204		2.0	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo River above Boulder Creek (Sta. 7)

Date and time sampled P.S.T.	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Per cent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e] DWR
							Mineral constituents in parts per million / equivalents per million																		
8/29/63 0855	3	59			650	7.8 / 8.2	76 / 3.79	13 / 1.11	42 / 1.83	2.4 / 0.06	0 / 0.00	220 / 3.60	81 / 1.69	51 / 1.44	0.6 / 0.01	0.4 / 0.02	0.32	21	PO_4 0.30; Fe 0.07; ABS 0.0; C=15	404c	27	245	65		
10/7/63 1015	2	57	9.5	92	731	8.0 / 8.1	5.13[a]		53 / 2.30		0 / 0.00	239 / 3.92		68 / 1.92	0.8 / 0.01				PO_4 0.36; Fe 0.17	455[d]		257			
11/6/63 1400	10	51	10.0	90	365	7.7 / 7.7	2.54[a]		21 / 0.91		0 / 0.00	86 / 1.41		21 / 0.59	1.7 / 0.03		0.1		PO_4 0.63; Fe 0.30; ABS 0.0	225[d]		127			
12/9/63 1550	6	46	11.3	95	582	7.7									0.2 / 0.00				PO_4 0.21	360[d]					
1/14/64 1125	4	39	12.9	98	628	7.9 / 8.1	4.60[a]				0 / 0.00	195 / 3.20		44 / 1.24	0.5 / 0.01				PO_4 0.23	390[d]		230			
2/19/64 1020	6	42			569	7.6 / 8.2	4.20[a]				0 / 0.00	166 / 2.72		35 / 0.99	0.5 / 0.01				PO_4 0.20; C=0	350[d]		210			
3/24/64 1130	8	46	12.2	102	496	8.0 / 7.8	3.56[a]				0 / 0.00	146 / 2.39		29 / 0.82	0.6 / 0.01				PO_4 0.21	310[d]		178		9.5	
4/21/64 1145	3	52	12.2	111	627	8.2 / 8.1	4.48[a]				0 / 0.00	195 / 3.20		46 / 1.30	0.0 / 0.00				PO_4 0.23	390[d]		224		3.0	
5/12/64 1300	2	60	10.7	107	654	8.2 / 8.3	4.58[a]				0 / 0.00	204 / 3.34		52 / 1.47	0.0 / 0.00				PO_4 0.34	405[d]		229		2.6	
6/25/64 0950	2	64	8.3	87	689	7.7 / 8.2	4.76[a]		48 / 2.09		0 / 0.00	219 / 3.59		59 / 1.66	1.2 / 0.02				PO_4 0.23	430[d]		238		2.5	
9/24/64 1500	2	64	8.5	89	924	7.8	5.39[a]							66 / 1.86	2.3 / 0.04				PO_4 0.32	575[d]		270		2.8	
12/9/64 1630	3	49	10.8	94	723	7.8								62 / 1.75	1.8 / 0.03				PO_4 0.22	450[d]				1.4	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves.

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Bear Creek above Bear Creek Estates (Sta. 8)
9S/2W-10E

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field	pH Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e] DWR
								Mineral constituents in parts per million / equivalents per million																		
8/29/63 1005	1	58			634	8.0	8.2	77 / 3.84	16 / 1.35	33 / 1.44	2.3 / 0.06	0 / 0.00	230 / 3.77	110 / 2.29	24 / 0.68	0.5 / 0.01	0.4 / 0.02	0.15	20	PO_4 0.25, Fe 0.03, ABS 0.0, C=20	412[c]	22	260	71		
10/7/63 0820	1/2	55	9.4	88	669	7.7	8.2	5.31[a]		42 / 1.83		0 / 0.00	245 / 4.02		27 / 0.76	0.8 / 0.01				PO_4 0.27, Fe 0.03	435[d]		266			
11/6/63 1430	3	52	10.1	92	505	7.9	7.9	4.02[a]		26 / 1.13		0 / 0.00	154 / 2.52		16 / 0.45	0.6 / 0.01				PO_4 0.27, Fe 0.08, ABS 0.0, Mn 0.00, SS 82	330[d]		201			
12/9/63 1530	2	47	10.9	93	581	8.1										0.0 / 0.00				PO_4 0.22	380[d]					
1/14/63 1100	1	40	12.6	97	614	7.9	8.3	5.03[a]				0 / 0.00	217 / 3.56		20 / 0.56	0.4 / 0.01				PO_4 0.20	400[d]		252			
2/19/64 1050	2	44			591	7.6	8.2	4.84[a]				0 / 0.00	195 / 3.20		17 / 0.48	0.5 / 0.01				PO_4 0.21	385[d]		242			
3/24/64 1600	3	47	11.3	96	514	8.1	7.9	4.10[a]				0 / 0.00	172 / 2.82		14 / 0.39	1.3 / 0.02				PO_4 0.22	335[d]		205		5.5	
4/21/64 1445	1-1/2	51	10.7	96	607	8.3	8.0	4.84[a]				0 / 0.00	214 / 3.51		20 / 0.56	1.3 / 0.02				PO_4 0.23	395[d]		242		2.5	
5/12/64 1400	1-1/2	63	9.9	102	624	8.2	8.3	4.98[a]				2 / 0.07	218 / 3.57		22 / 0.62	0.0 / 0.00				PO_4 0.28	405[d]		249		1.5	
6/24/64 1220	1	70	9.0	100	644	7.7	8.4	5.05[a]		38 / 1.65		4 / 0.13	225 / 3.69		28 / 0.79	1.0 / 0.02				PO_4 0.21	420[d]		253		2.0	
7/21/64 0945	1	60	9.5	95	711	7.6	8.3	5.31[a]				0 / 0.00	251 / 4.11		36 / 1.02	0.0 / 0.00				PO_4 0.20	465[d]		266		0.8	
8/18/64 0945	3/4	59	8.9	88	905	7.9									89 / 2.51	0.4 / 0.01				PO_4 0.25, ABS 0.0	590[d]				0.5	
9/23/64 1200	1/2	60	9.3	93	818	7.9		5.41[a]							82 / 2.31	2.5 / 0.04				PO_4 1.4	530[d]		271		1.8	
11/11/64 1000	4-1/2				579		7.9	70 / 3.49	11 / 0.89	28 / 1.22	2.2 / 0.06	0 / 0.00	149 / 2.44	125 / 2.60	25 / 0.70	1.2 / 0.02		0.1			376[c]	22	219	97		

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves.

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Bear Creek near Boulder Creek (Sta. 9)
9S/2W-30B

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen % Sat	Specific conductance (micromhos at 25° C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO3)	Bicarbonate (HCO3)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Fluoride (F)	Boron (B)	Silica (SiO2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as CaCO3 Total ppm	Hardness as CaCO3 N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		
8/[illegible]/63 0910	2	59			595	8.1 / 8.2	71 / 3.54	13 / 1.06	38 / 1.65	2.2 / 0.06	0 / 0.00	210 / 3.44	98 / 2.04	27 / 0.76	0.4 / 0.01	0.4 / 0.02	0.13	21	PO4 0.27, Fe 0.06; ABS 0.0, C=15	383[c]	26	230	58		DWR
10/7/63 0915	1	55	9.5	89	626	7.9 / 8.1	4.62[a]		43 / 1.87		0 / 0.00	219 / 3.59		32 / 0.90	1.0 / 0.02				PO4 0.32, Fe 0.12	405[d]		231			
11/6/63 1400	5	52	10.0	91	400	7.8 / 7.8	2.90[a]		22 / 0.96		0 / 0.00	100 / 1.64		14 / 0.39	1.4 / 0.02		0.1		PO4 0.42, Fe 0.24; ABS 0.0	260[d]		145			
12/9/63 1600	3	46	11.3	95	559	7.7									0.0 / 0.00				PO4 0.19	360[d]					
1/14/64 1140	2	39	12.0	96	580	8.0 / 8.1	4.52[a]				0 / 0.00	195 / 3.20		24 / 0.68	0.5 / 0.01				PO4 0.25	375[d]		226			
2/19/64 1030	4	42			551	7.4 / 8.2	4.20[a]				0 / 0.00	170 / 2.79		21 / 0.59	0.5 / 0.01				PO4 0.16, C=0	355[d]		210			
3/24/64 1140	5	45	12.2	101	484	8.1 / 7.8	3.62[a]				0 / 0.00	151 / 2.47		19 / 0.54	0.5 / 0.01				PO4 0.18	310[d]		181		9.5	
4/21/64 1230	3	52	12.0	109	587	8.2 / 8.0	4.36[a]				0 / 0.00	194 / 3.18		25 / 0.70	2.0 / 0.03				PO4 0.19, Fe 0.20	380[d]		218		3.8	
5/12/64 1325	2-1/2	59	10.7	106	593	8.2 / 8.3	4.42[a]				0 / 0.00	200 / 3.28		28 / 0.79	0.0 / 0.00				PO4 0.25	380[d]		221		2.8	
6/24/64 1015	2	63	9.2	95	608	7.7 / 8.4	4.48[a]		38 / 1.65		2 / 0.07	209 / 3.42		34 / 0.96	0.9 / 0.01				PO4 0.23	390[d]		224		1.5	
7/21/64 1015	3	61	8.8	89	656	7.6 / 8.2	4.58[a]				0 / 0.00	222 / 3.64		42 / 1.18	0.0 / 0.00				PO4 0.32	420[d]		229			
8/18/64 1030	1	61	8.9		650	7.8		Sample	broken	by lab	oratory									420[d]				0	
[illegible]/23/64 1010		55	8.4		706	7.8	4.58							31 / 0.87	0.8 / 0.01				PO4 0.32	455[d]		229		0.5	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves.

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Boulder Creek above Jamison Road (Sta. 10)
9S/3W-14J

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e]
							Mineral constituents in parts per million / equivalents per million																		DWR
10/10/63 1220	1/4	56	4.2	40	289	7.1																			
11/7/63 0940	1	49	10.4	91	284	7.3																			
12/10/63 1050	1	47	11.7	99	298	7.2																			
1/14/64 1025	1	39	12.6	96	348	7.5 / 7.6	2.10[a]				0 / 0.00	71 / 1.16		24 / 0.68	0.5 / 0.01				PO_4 0.36			105			
3/24/64 1035	2	44	12.0	98	234	7.3 / 7.3	1.42[a]				0 / 0.00	52 / 0.85		15 / 0.42	1.0 / 0.02				PO_4 0.10			71		20	
4/21/64 1100	1-1/2	50	11.0	97	349	7.3 / 7.2	2.00[a]				0 / 0.00	69 / 1.13		22 / 0.62	1.0 / 0.02				PO_4 0.43			100		4.5	
5/12/64 1040	1	54	10.0	93	351	7.3 / 7.8	2.04[a]				0 / 0.00	77 / 1.26		24 / 0.68	0.1 / 0.00				PO_4 0.07			102		4.8	
6/25/64 1205	1/2	65	7.9	84	386	7.9 / 7.6	2.20[a]		27 / 1.17		0 / 0.00	75 / 1.23		30 / 0.85	0.8 / 0.01				PO_4 0.06			110		5.0	
7/21/64 1215	1/2	61	7.2	73	409	7.1 / 7.9	2.32[a]				0 / 0.00	92 / 1.51		34 / 0.96	0.5 / 0.01				PO_4 0.30			116		1.9	
8/18/64 1115	1/2	63	6.1	63	336	7.3								20 / 0.56	0.9 / 0.01				PO_4 0.47 ABS 0.1					11	
9/23/64 0920	1/2	53	3.7	34	375	7.3	2.58							28 / 0.79	2.0 / 0.03				PO_4 0.16 ABS 0.0			129		1.2	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Boulder Creek at Boulder Creek (Sta. 12)
9S/2W-30B

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e] DWR
							Mineral constituents in parts per million / equivalents per million																		
8/29/63 1240	5	60			204	7.9 / 7.9	22 / 1.10	5.4 / 0.44	13 / 0.56	2.1 / 0.05	0 / 0.00	95 / 1.56	9.0 / 0.19	12 / 0.34	0.8 / 0.01	0.1 / 0.00	0.04	23	PO_4 0.16, Fe 0.03, ABS 0.0, C=10	132[c]	26	77	0		
10/7/63 1105	3	57	9.8	94	207	7.7 / 7.5	1.64[a]		10 / 0.44		0 / 0.00	99 / 1.62		7.4 / 0.21	0.7 / 0.01				PO_4 0.19, Fe 0.02	135[d]		82			
11/6/63 1330	12	53	10.3	95	166	7.4 / 7.5	1.18[a]		10 / 0.43		0 / 0.00	57 / 0.93		8.8 / 0.25	0.5 / 0.01				PO_4 0.21, ABS 0.0	105[d]		59			
12/10/63 1110	8	46	11.5	97	205	7.4									0.2 / 0.00				PO_4 0.07	130[d]					
1/14/64 1245	7	43	12.2	98	208	7.7 / 7.8	1.58[a]				0 / 0.00	85 / 1.39		9.9 / 0.28	1.2 / 0.02				PO_4 0.09	135[d]		79			
2/19/64 0955	8	45			198	7.4 / 7.8	1.46[a]				0 / 0.00	80 / 1.31		8.8 / 0.25	0.3 / 0.00				PO_4 0.08, C=0	130[d]		73			
3/24/64 1020	10	46	12.5	105	185	7.6 / 7.3	1.30[a]				0 / 0.00	66 / 1.08		8.3 / 0.23	1.5 / 0.02				PO_4 0.08	120[d]		65		9.5	
4/21/64 1130	5	52	11.5	104	207	7.9 / 7.7	1.56[a]				0 / 0.00	87 / 1.42		9.5 / 0.27	0.1 / 0.00				PO_4 0.08	135[d]		78		4.0	
5/12/64 1100	3	54	10.5	98	214	7.9 / 8.0	1.62[a]				0 / 0.00	92 / 1.51		9.7 / 0.27	0.2 / 0.00				PO_4 0.18	140[d]		81		0.05	
6/24/64 0950	4	62	9.0	92	235	7.3 / 8.0	1.72[a]		11 / 0.48		0 / 0.00	102 / 1.67		11 / 0.31	1.1 / 0.02				PO_4 0.13	150[d]		86		1.5	
7/21/64 1140	4	60	9.3	93	235	7.5 / 8.0	1.76[a]				0 / 0.00	107 / 1.75		5.9 / 0.17	0.0 / 0.00				PO_4 0.20	150[d]		88		2.5	
8/18/64 1140	5	63	9.6	99	245	8.0								12 / 0.34	1.4 / 0.02				PO_4 0.25, ABS 0.0	160[d]				0.8	
9/23/64 0955	4	57	9.7	94	242	7.6	1.88[a]							11 / 0.31	1.0 / 0.02				PO_4 0.25	155[d]		94		2.9	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo River below Boulder Creek (Sta. 13)
9S/2W-30H

Date and time sampled P.S.T.	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e] DWR
							Mineral constituents in parts per million / equivalents per million																		
7/21/64 1200	8	70	8.0	89	506	7.4 / 8.2	/ 3.42[a]				0 / 0.00	171 / 2.80		43 / 1.21	0.0 / 0.00				PO_4 0.25			171		1.2	
8/18 64 1200	7	67	8.5	92	517	8.1								48 / 1.35	0.4 / 0.01				PO_4 0.24 ABS 0.0					2.9	

a Sum of calcium and magnesium in epm
b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).
c Gravimetric determination
d Derived from conductivity vs TDS curves
e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Clear Creek (Sta. 16)

9S/2W-32F

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/29/63 1305	1	58			181	7.4 / 7.7	21 / 1.05	4.0 / 0.33	11 / 0.48	2.2 / 0.06	0 / 0.00	92 / 1.51	4.8 / 0.10	8.8 / 0.25	0.4 / 0.01	0.1 / 0.00	0.04	23	PO_4 0.04; Fe 0.01; ABS 0.0; C=5	120[c]	25	69	0		
10/8/63 0830	1/2	56	9.9	94	189	7.5 /														125[d]					
11/7/63 1050	1	52	10.7	97	176	7.6 /														115[d]					
12/10/63 1135	1	48	11.3	97	170	7.4 /														115[d]					
1/14/64 1405	1	48	11.5	99	162	7.4 /														110[d]					
3/24/64 1645	1	47	11.7	99	162	7.4 / 7.5	/ 1.22[a]				0 / 0.00	80 / 1.31		6.2 / 0.17	1.2 / 0.02				PO_4 0.02	110[d]		61		0.7	
4/22/64 0845	1/2	48	11.4	98	173	7.7 / 7.6	/ 1.30[a]				0 / 0.00	89 / 1.46		6.4 / 0.18	0.4 / 0.01				PO_4 0.04	115[d]		65		0.0	
5/12/64 1440	1/2	56	10.3	98	181	7.7 / 7.9	/ 1.36[a]				0 / 0.00	92 / 1.51		7.0 / 0.20	0.0 / 0.00				PO_4 0.07	120[d]		68		0.05	
9/23/64 1240	1/4	60.5	9.3	93	213	7.6 /	/ 1.56[a]							9.1 / 0.26	1.5 / 0.02				PO_4 0.08	140[d]		78		0.9	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Alba Creek (Sta. 17)

9S/2W-32K

Date and time sampled P.S.T.	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by [e] DWR
10/10/63 1400	1/10	58	8.0	78	228	6.8 /																			
11/7/63 1130	1/2	51	10.7	96	190	7.8 /																			
12/10/63 1250	1/10	47	10.1	86	177	6.8 /																			
1/14/64 1420	1/10	46	10.4	87	206	6.8 /																			
3/25/64 1015	1/10	47	11.5	98	161	7.1 /	/ 1.14[a]				0 / 0.00	64 / 1.05		8.2 / 0.23	1.3 / 0.02				PO_4 0.30			57		7.5	

Mineral constituents in parts per million / equivalents per million

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Marshall Creek (Sta. 18)
10S/2W-5H

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e]
							Mineral constituents in parts per million / equivalents per million																		DWR
10/10/63 1500	1/4	59	9.8	97	235	7.3																			
11/7/63 1110	1/2	51	10.5	94	217	7.6																			
12/10/63 1305	1/4	47	11.1	94	208	7.3																			
1/15/64 0910	1/4	43	12.2	98	219	7.4																			
3/25/64 1030	1/2	46	11.8	99	215	7.5 / 7.6	1.56[a]				0 / 0.00	92 / 1.51		8.4 / 0.24	0.8 / 0.01				PO_4 0.10			78		1.5	
4/22/64 0910	1/2	48	11.4	98	224	7.7 / 7.7	1.64[a]				0.00	104 / 1.70		8.9 / 0.25	0.3 / 0.00				PO_4 0.13			82		1.7	
5/13/64 0910	1/2	51	10.8	97	237	7.7 / 8.0	1.74[a]				0 / 0.00	108 / 1.77		9.3 / 0.26	0.0 / 0.00				PO_4 0.15			87		1.5	
9/23/64 1317	1/4	59	9.8	97	304	7.7	2.20[a]							12 / 0.34	1.8 / 0.03				PO_4 0.20			110		0.5	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Love Creek (Sta. 20)

10S/2W-4L

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e] DWR
8/29/63 1330	1/4	63			388	7.8 / 8.0	48 / 2.40	7.5 / 0.62	21 / 0.91	1.8 / 0.05	0 / 0.00	152 / 2.49	38 / 0.79	23 / 0.65	0.6 / 0.01	0.3 / 0.02	0.10	33	PO_4 0.73, FE 0.05, ABS 0.0, C=10	253[c]	23	151	26		
10/8/63 0930	1/4	57	9.5	92	406	7.9														265[d]					
11/7/63 1200	1/2	49	10.6	92	366	7.6														240[d]					
12/10/63 1225	1/4	44	11.6	94	367	7.4														240[d]					
1/15/64 0930	1/4	38	12.7	95	390	7.8 / 8.0	2.94[a]				0 / 0.00	140 / 2.29		22 / 0.62	0.7 / 0.01				PO_4 0.59	255[d]		147			
2/19/64 1220	1/2	46			361	7.6 / 7.8	2.74[a]				0 / 0.00	129 / 2.11		18 / 0.51	1.5 / 0.02				PO_4 0.55, C=0	235[d]		137			
3/25/64 1100	1/2	44	12.6	103	342	7.9 / 7.7	2.56[a]				0 / 0.00	123 / 2.02		17 / 0.48	1.3 / 0.02				PO_4 0.51	220[d]		128		4.5	
4/22/64 0935	1/4	49	11.5	100	391	8.0 / 7.9	2.94[a]				0 / 0.00	146 / 2.39		21 / 0.59	0.2 / 0.00				PO_4 0.52	255[d]		147		0.7	
5/13/64 0930	1/4	53	10.4	95	408	7.8 / 8.2	2.96[a]				0 / 0.00	153 / 2.51		22 / 0.62	0.1 / 0.00				PO_4 0.75	265[d]		148		0.4	
7/21/64 1300	1/4	60	9.1	91	436	7.6 / 8.3	3.30[a]				0 / 0.00	170 / 2.79		25 / 0.70	0.0 / 0.00				PO_4 0.74	285[d]		165		0.6	
8/18/64 0850	< 1/4	58	9.2	90	467	7.9								25 / 0.70	0.5 / 0.01				PO_4 0.85, ABB 0.0	305[d]				1.5	
9/23/64 1330	Dry																								

Mineral constituents in parts per million / equivalents per million.

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Newell Creek below Loch Lomond (Sta. 21)
(includes discharge from springs)
10S/2W-3D

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e] DWR
							Mineral constituents in parts per million / equivalents per million																		
10/8/63 1025	1	64	8.6	90	557	7.6 / 7.9	4.56[a]		25 / 1.09		0 / 0.00	152 / 2.49		20 / 0.56	1.3 / .02				PO_4 0.16, Fe 0.46, Mn 0.00, SS 3.6			228			
12/5/63 1340	1	51	9.9	89	562	7.3									1.0 / 0.02				PO_4 0.30, Fe 0.51, C=10						
1/15/64 0955	1	47	10.0	85	581	7.3 / 8.1	5.00[a]				0 / 0.00	162 / 2.66		20 / 0.56	1.5 / 0.02				PO_4 0.25			250			
3/25/64 1130	1	53	10.9	100	562	7.7 / 7.9	4.78[a]				0 / 0.00	164 / 2.69		18 / 0.51	0.9 / 0.01				PO_4 0.16			239		3.3	
4/22/64 1005	1	51	9.9	89	553	7.8 / 7.9	4.64[a]				0 / 0.00	162 / 2.66		18 / 0.51	0.5 / 0.01				PO_4 0.16			232		3.7	
5/13/64 0945	1	58	9.6	94	553	7.7 / 8.0	4.66[a]				0 / 0.00	164 / 2.69		20 / 0.56	0.3 / 0.00				PO_4 0.16			233		2.7	
6/26/64 0805	1	54	9.9	92	552	7.3 / 8.1	4.66[a]		21 / 0.91		0 / 0.00	166 / 2.72		20 / 0.56	1.2 / 0.02				PO_4 0.13			233		3.5	
7/21/64 1310	1	58	10.0	98	538	7.4 / 8.1	4.56[a]				0 / 0.00	162 / 2.66		18 / 0.51	0.0 / 0.00				PO_4 0.21			228		1.5	
8/18/64 0910	1	55	9.8	92	571	7.4								20 / 0.56	0.6 / 0.01				PO_4 0.29, ABS 0.0					1.8	
9/22/64 1040	1	53	8.8	81	574	6.0	4.88[a]							20 / 0.56	1.7 / 0.03				PO_4 0.99, Fe 0.01, Odor of H_2S			244		5.8	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated.

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Loch Lomond (Sta. 21-A)
10S/2W-3D

Date and time sampled P S T	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		
6/26/62					385	/ 7.9	48 / 2.40	12 / 0.99	20 / 0.87	3.3 / 0.08	0 / 0.00	115 / 1.78	110 / 2.29	12 / 0.34	0.7 / 0.01			18	Free CO_2 2; Fe 0.17; Mn < 0.01	269[c]		168			Brown & Caldwell
8/29/63 1450		52			414	6.8 / 7.9	58 / 2.89	6.7 / 0.55	17 / 0.74	2.6 / 0.07	0 / 0.00	120 / 1.97	86 / 1.79	12 / 0.34	1.2 / 0.02	0.3 / 0.02	0.09	19	PO_4 0.33; Fe 0.37; ABS 0.0; Color 35	276[c]	17	172	74		DWR
11/7/63 1330		61	7.0	71	422	7.3 / 7.9	/ 3.42[a]		18 / 0.78		0 / 0.00	128 / 2.10		11 / 0.31	0.6 / 0.01				PO_4 0.27; Fe 0.41; ABS 0.0; Mn 0.00; SS 2	280[d]		171			DWR
2/19/64 1245		50	9.9	87	416	7.3 / 7.8	/ 3.38[a]				0 / 0.00	129 / 2.11		11 / 0.31	0.8 / 0.01				PO_4 0.17; C=5	275[d]		169			DWR

a Sum of calcium and magnesium in epm
b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).
c Gravimetric determination
d Derived from conductivity vs TDS curves
e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Loch Lomond Water before Treatment

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Alkalinity as $CaCO_3$	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e] SC
11/22/61						7.5								32					220			270		5.0	
12/20/61						7.7								37					206			275		3.0	
1/25/62						8.3								35					184			283		7.0	
2/21/62						8.8								21					106			167		45	
3/21/62						7.8								19					80			125		25	
4/25/62						8.1								18					92			129		4.0	
5/16/62						9.0								19					96			141		5.0	
6/20/62						8.0								19					100			140		0.8	
7/18/62						8.1								19					110			160		1.5	
8/15/62						7.5								18					112			183		0.4	
9/19/62						7.7								19					114			181		0.3	
10/17/62						7.7								17					118			177		15	
11/21/62						7.8								18					108			159		2.0	
12/26/62						7.4								18					104			170		2.0	
1/17/63						7.9								18					154			170		2.0	
2/20/63						7.8								15					108			162		15	
3/20/63						7.7								11					70			98		[illegible].0	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Loch Lomond Water before Treatment

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen		Specific conductance (micromhos at 25°C)	pH Field / Lab	Mineral constituents in parts per million / equivalents per million													Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$		Turbidity in ppm	Analyzed by [e]
			ppm	% Sat			Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Alkalinity			Total ppm	N C ppm		SC
4/17/63						7.6								13					74			106		5.0	
5/15/63						8.8								12					80			117		1.5	
6/19/63						7.4								14					92			165		1.5	
7/17/63						7.1								15					116			187		0.4	
8/31/63						9.0								15					110			147		2.5	
9/30/63						8.0								15					112			151		0.9	
10/31/63						7.9								13					110			150		0.8	
11/30/63						7.2								16					120			180		5.0	
12/31/63						7.2								14					114			174		1.9	
1/31/64						7.3								11					72			97		1.2	
2/29/64						8.9								11					72			90		0.9	
3/31/64						8.2								12					60			101		0.8	
4/30/64						7.9								12					112			115		0.8	
5/31/64						8.1								13					98			170		1.4	
6/30/64						8.0								10.5					120			170		1.5	
7/31/64						8.2								13					132			176		0.8	
8/31/64						7.6								16					130			147		1.1	
9/30/64						8.0								17					112			182		2.0	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Fall Creek (Sta. 24)
10S/2W-16J

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e] DWR
							Mineral constituents in parts per million / equivalents per million																		
8/29/63 1520	2	58			259	8.0 / 8.0	41 / 2.04	3.9 / 0.32	9.8 / 0.43	2.2 / 0.06	0 / 0.00	140 / 2.29	9.7 / 0.20	9.8 / 0.28	0.4 / 0.01	0.1 / 0.00	0.02	23	PO_4 0.09, Fe 0.02, ABS 0.0, C=10	167[c]	15	118	3		
10/8/63 1115	2	56	10.0	95	270	7.9														175[d]					
11/7/63 1430	2	52	10.8	98	254	8.1														165[d]					
12/11/63 1225	1-1/2	45	11.8	97	260	7.9														165[d]					
1/15/64 1020	2	43	12.3	99	258	8.0 / 8.0	2.28[a]				0 / 0.00	130 / 2.13		7.8 / 0.22	0.2 / 0.00				PO_4 0.09	165[d]		114			
3/25/64 1215	1-1/2	47	12.1	103	235	8.0 / 7.8	2.02[a]				0 / 0.00	117 / 1.92		8.5 / 0.24	0.8 / 0.01				PO_4 0.07	150[d]		101		2	
4/22/64 1045	2	49	11.3	98	256	8.1 / 7.9	2.22[a]				0 / 0.00	132 / 2.16		8.2 / 0.23	0.0 / 0.00				PO_4 0.14	165[d]		111		2.2	
5/13/64 0945	2-1/2	51	11.0	98	258	8.1 / 8.2	2.28[a]				0 / 0.00	136 / 2.23		8.4 / 0.24	0.1 / 0.00				PO_4 0.11	165[d]		114		0.9	
7/22/64 0955	2-1/2	56	10.1	96	286	7.6 / 8.4	2.46[a]				4 / 0.13	140 / 2.29		8.4 / 0.24	0.6 / 0.01				PO_4 0.13	185[d]		123		0.4	
8/18/64 0830	2	55	10.3	97	284	8.0								8.3 / 0.23	0.1 / 0.00				PO_4 0.14, ABS 0.0	183[d]				0.3	
9/23/64 1340	2	59	9.9	98	303	7.9	2.56[a]							10 / 0.28	0.7 / 0.01				PO_4 0.13	195[d]		128		0.2	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo River near Felton (Sta. 25)

10S/2W-22F

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e]
							Mineral constituents in parts per million / equivalents per million																		
8/29/63 1535	20	66			379	8.0 / 7.9	48 / 2.40	6.3 / 0.52	20 / 0.87	2.3 / 0.06	0 / 0.00	146 / 2.39	40 / 0.83	22 / 0.62	0.7 / 0.01	0.2 / 0.01	0.09	23	PO_4 0.34; Fe 0.11; ABS 0.0; C=10	236[c]	22	146	26		DWR
10/8/63 1210	8	60	9.8	98	390	7.8 / 7.7	2.88[a]		22 / 0.96		0 / 0.00	143 / 2.34		22 / 0.62	1.2 / 0.02				PO_4 0.37; Fe 0.16; Mn 0.00; SS 0.8	240[d]		144			
11/6/63 0945	35	54	9.7	90	295	7.5 / 7.6	2.14[a]		16 / 0.70		0 / 0.00	76 / 1.24		16 / 0.45	1.8 / 0.03				PO_4 0.51; Fe 0.69; ABS 0.0; Mn 0.00; SS 824	185[d]		107			
12/11/63 1030	30	42	12.0	95	375	7.4									0.6 / 0.01				PO_4 0.29	235[d]					
1/15/64 1050	25	42	13.7	108	391	7.9 / 7.8	2.92[a]				0 / 0.00	137 / 2.24		20 / 0.56	0.5 / 0.01				PO_4 0.24	245[d]		146			
2/19/64 1555	30	49	11.3	98	378	7.5 / 7.9	2.76[a]				0 / 0.00	127 / 2.08		18 / 0.51	1.0 / 0.02				PO_4 0.23; C=0	235[d]		138			
3/25/64 1230	35	50	12.3	109	349	7.9 / 7.6	2.54[a]				0 / 0.00	115 / 1.88		17 / 0.48	1.1 / 0.02				PO_4 0.24; SS 0.8	220[d]		127		3.5	
4/22/64 1110	20	53	10.7	98	387	7.9 / 7.7	2.84[a]				0 / 0.00	141 / 2.31		21 / 0.59	1.3 / 0.02				PO_4 0.26; Fe 0.89; SS 32	240[d]		142		8.0	
5/13/64 1045	18	52	10.1	92	394	7.9 / 7.9	2.88[a]				0 / 0.00	142 / 2.33		22 / 0.62	0.3 / 0.00				PO_4 0.32	245[d]		144		2.5	
6/23/64 1205	15	70	10.5	117	383	8.0 / 8.3	2.82[a]		21 / 0.91		0 / 0.00	143 / 2.34		22 / 0.62	1.2 / 0.02				PO_4 0.34	240[d]		141		2.0	
7/22/64 0800	18	61	7.3	74	380	7.3 / 7.9	2.80[a]				0 / 0.00	144 / 2.36		21 / 0.59	0.4 / 0.01				PO_4 0.30	230[d]		140		0.8	
8/17/64 1545	18	71	9.7	109	376	8.0								22 / 0.62	0.3 / 0.00				PO_4 0.44; ABS 0.0	235[d]				2.6	
9/23/64 1410	16	67	9.8	106	386	7.7	2.72[a]							28 / 0.79	0.7 / 0.01				PO_4 0.40	240[d]		136		1.8	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Zayante Creek at Zayante (Sta. 26)
10S/2W-2K

Date and time sampled P.S.T.	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field	pH Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e] DWR
								Mineral constituents in parts per million / equivalents per million																		
8/30/63 0850	2	59			628	8.2	8.3	77 / 3.84	15 / 1.27	36 / 1.57	2.6 / 0.07	0 / 0.00	232 / 3.80	104 / 2.16	25 / 0.70	0.4 / 0.01	0.5 / 0.03	0.13	26	PO_4 0.44, Fe 0.11, ABS 0.0, C=10	412[c]	23	256	66		
10/8/63 1330	3/4	58	10.1	99	662	8.1	8.2	5.19[a]		42 / 1.83		0 / 0.00	248 / 4.06		29 / 0.82	1.2 / 0.02				PO_4 0.51, Fe 0.62, Mn 0.00, SS 14	435[d]		260			
11/6/63 1110	4	52	10.2	92	481	7.9	7.9	3.62[a]		27 / 1.17		0 / 0.00	142 / 2.33		19 / 0.54	1.6 / 0.03				PO_4 0.61, Fe 1.3, ABS 0.0, SS 434, Mn 0.00	315[d]		181			
12/10/63 1420	2	42	11.9	94	631	7.9										0.0 / 0.00				PO_4 0.32	415[d]					
1/15/64 1250	1	40	13.4	103	653	8.1	8.2	5.31[a]				0 / 0.00	230 / 3.77		27 / 0.76	0.6 / 0.01				PO_4 0.31	430[d]		266			
2/20/64 0925	2	43			626	7.5	8.1	5.01[a]				0 / 0.00	209 / 3.42		22 / 0.62	0.4 / 0.01				PO_4 0.30	410[d]		251			
3/25/64 1430	2	46	12.2	102	600	8.2	8.0	4.80[a]				0 / 0.00	205 / 3.36		22 / 0.62	0.6 / 0.01				PO_4 0.32, SS 4	395[d]		240		2.7	
4/22/64 1330	1	53	11.6	106	664	8.4	8.1	5.21[a]				0 / 0.00	236 / 3.87		36 / 1.02	1.8 / 0.03				PO_4 0.34, Fe 0.08, SS 5	435[d]		261		2.2	
5/13/64 1330	1-1/2	58	10.8	105	672	8.4	8.4	5.31[a]				4 / 0.13	242 / 3.97		31 / 0.87	0.2 / 0.00				PO_4 0.40	440[d]		266		0.5	
6/23/64 1330	1-1/2	67	9.0	97	686	7.9	8.3	5.37[a]		40 / 1.74		0 / 0.00	256 / 4.20		33 / 0.93	0.9 / 0.01				PO_4 0.37	450[d]		269		2.5	
7/22/64 0830	1	58	9.8	96	733	7.7	8.4	5.59[a]				4 / 0.13	267 / 4.38		37 / 1.04	1.0 / 0.02				PO_4 0.50	480[d]		280		0.2	
8/18/64 0740	1	56	9.6	91	754	8.1									42 / 1.18	0.4 / 0.01				PO_4 0.51, ABS 0.0	495[d]				3.6	
9/23/64 1530	3/4	63	9.0	93	775	8.3		6.01[a]							46 / 1.30	1.8 / 0.03				PO_4 0.51	510[d]		301		0.5	
11/11/65 0935	5				596		8.3	67 / 3.34	12 / 0.98	34 / 1.48	2.8 / 0.07	0 / 0.00	171 / 2.80	114 / 2.37	30 / 0.85	0 / 0.00		0.2		Fe 7.8	389[c]	25	216	76		

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Lompico Creek (Sta. 27)
10S/2W-11C

Date and time sampled P.S.T.	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen % Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		
8/30/63 0915	1/2	58			604	8.1 / 8.1	83 / 4.14	15 / 1.23	27 / 1.17	2.0 / 0.05	0 / 0.00	303 / 4.97	48 / 1.00	20 / 0.56	0.4 / 0.01	0.3 / 0.02	0.11	32	PO_4 0.70 ABS 0.0	388[c]	18	269	21		DWR
10/8/63 1415	1/4	58	9.8	96	606	8.2														390[d]					
11/6/63 1145	1	52	10.2	92	383	8.0													Slight Odor	245[d]					
12/11/63 1125	1	41	12.0	94	418	7.8														270[d]					
1/15/64 1230	1/4	41	12.6	98	481	7.9 / 8.3	4.24[a]				0 / 0.00	228 / 3.74		18 / 0.51	0.9 / 0.01				PO_4 0.38	310[d]		212			
2/20/64 1000	1/2	45			446	7.9 / 8.1	3.72[a]				0 / 0.00	199 / 3.26		16 / 0.45	1.2 / 0.02				PO_4 0.40 C=5	285[d]		186			
3/25/64 1400	3/4	48	12.2	105	428	8.1 / 7.8	3.54[a]				0 / 0.00	187 / 3.06		16 / 0.45	1.0 / 0.02				PO_4 0.39	275[d]		177		4	
4/22/64 1300	1/2	52	11.6	105	506	8.3 / 8.2	4.32[a]				0 / 0.00	239 / 3.92		18 / 0.51	0.3 / 0.00				PO_4 0.45	325[d]		216		2.5	
5/13/64 1310	1/4	54	10.9	101	517	8.2 / 8.3	4.42[a]				0 / 0.00	247 / 4.05		20 / 0.56	0.7 / 0.01				PO_4 0.49	330[d]		221		1.6	
7/22/64 0850	1/2	56	9.1	87	614	7.7 / 8.2	5.39[a]				0 / 0.00	314 / 5.15		21 / 0.59	1.2 / 0.02				PO_4 0.68	395[d]		270		1.1	
8/18/64 0715	1/2	56	9.2	88	646	8.2								21 / 0.59	0.5 / 0.01				PO_4 0.70 ABS 0.0	415[d]				1.6	
9/23/64 1515	1/2	60	9.3	93	649	8.1	5.87[a]							22 / 0.62	1.5 / 0.02				PO_4 0.65	415[d]		294		1.3	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Bean Creek (Sta. 28)
10S/2W-22A

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/30/63 1000	4	58			383	8.0 / 7.9	43 / 2.14	6.1 / 0.50	24 / 1.04	1.6 / 0.04	0 / 0.00	119 / 1.95	47 / 0.98	27 / 0.76	1.8 / 0.03	0.3 / 0.02	0.09	36	PO_4 1.2; Fe 0.28; ABS 0.0; C=10	249[c]	28	132	34		
10/8/63 1530	2	58	9.6	94	380	7.8 / 7.7	2.58[a]		25 / 1.09		0 / 0.00	113 / 1.85		26 / 0.73	2.5 / 0.04				PO_4 1.5; Fe 1.1; Mn 0.00; SS 14	245[d]		129			
11/6/63 1030	8	53	10.0	92	334	7.6 / 7.6	2.28[a]		19 / 0.83		0 / 0.00	85 / 1.39		20 / 0.56	2.0 / 0.03				PO_4 2.4; Fe 0.21; ABS 0.0; Mn 0.00; SS 1440	215[d]		114			
12/11/63 1200	4	44	11.6	94	390	7.5									2.1 / 0.03				PO_4 0.89	255[d]					
1/15/64 1130	4	44	11.7	95	393	7.5 / 8.0	2.76[a]				0 / 0.00	118 / 1.93		27 / 0.76	2.6 / 0.04				PO_4 0.88	255[d]		138			
2/20/64 1040	4	48			399	7.4 / 7.8	2.82[a]				0 / 0.00	120 / 1.97		24 / 0.68	1.7 / 0.03				PO_4 0.83; C=0	260[d]		141			
3/25/64 1340	4	52	10.9	99	386	7.8 / 7.5	2.72[a]				0 / 0.00	116 / 1.90		23 / 0.65	2.6 / 0.04				PO_4 0.95; SS 32	250[d]		136		12	
4/22/64 1230	3	53	10.3	95	392	7.8 / 7.6	2.66[a]				0 / 0.00	122 / 2.00		26 / 0.73	2.0 / 0.03				PO_4 1.1; Fe 1.2; SS 33	255[d]		133		14	
5/13/64 1245	2-1/2	57	10.1	97	397	8.0 / 8.0	2.72[a]				0 / 0.00	122 / 2.00		28 / 0.79	1.5 / 0.02				PO_4 1.0	260[d]		136		7.5	
6/23/64 1300	2	64	8.9	93	409	7.5 / 8.2	2.82[a]		23 / 1.00		0 / 0.00	126 / 2.06		28 / 0.79	2.2 / 0.04				PO_4 0.70	265[d]		141		4.0	
7/22/64 0920	2-1/2	57	9.8	94	413	7.4 / 8.0	2.86[a]				0 / 0.00	129 / 2.11		29 / 0.82	2.1 / 0.03				PO_4 1.0	270[d]		143		2.0	
8/18/64 0805	2-1/2	55	10.2	96	417	7.8								28 / 0.79	2.0 / 0.03				PO_4 0.96; ABS 0.0	270[d]				3.2	
9/23/64 1455	2	60	9.7	97	408	7.8	2.78[a]							30 / 0.85	3.2 / 0.05				PO_4 1.1	265[d]		139		2.1	
12/10/64 0745	3	52	10.8	98	427	7.6								29 / 0.82	2.0 / 0.03				PO_4 1.2	280				5	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Zayante Creek near Felton (Sta. 30)

10S/2W-22F

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO₃)	Bicarbonate (HCO₃)	Sulfate (SO₄)	Chloride (Cl)	Nitrate (NO₃)	Fluoride (F)	Boron (B)	Silica (SiO₂)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as CaCO₃ Total ppm	Hardness as CaCO₃ N C ppm	Turbidity in ppm	Analyzed by[e] DWR
8/29/63 1545	8	62			394	8.1 / 8.0	45 / 2.24	7.3 / 0.60	24 / 1.04	1.8 / 0.05	0 / 0.00	132 / 2.16	48 / 1.00	24 / 0.68	1.2 / 0.02	0.3 / 0.02	0.10	32	PO₄ 1.1; Fe 0.26; ABS 0.0; C=10	253[c]	26	142	34		
10/8/63 1230	3	59	10.4	103	383	8.0 / 7.7	2.56[a]		25 / 1.09		0 / 0.00	124 / 2.03		24 / 0.68	1.8 / 0.03				PO₄ 0.99; Fe 0.32; Mn 0.00; SS 3.6	245[d]		128			
11/6/63 0950	15	53	10.0	92	344	7.7 / 7.7	2.42[a]		20 / 0.87		0 / 0.00	94 / 1.54		18 / 0.51	2.3 / 0.04				PO₄ 1.1; Fe 0.73; ABS 0.0; Mn 0.00; SS 660	220[d]		121			
12/11/63 1045	8	42	12.3	97	410	7.8									2.0 / 0.03				PO₄ 0.71	265[d]					
1/15/64 1105	6	41	13.6	106	403	8.3 / 8.0	2.94[a]				0 / 0.00	131 / 2.15		23 / 0.65	1.8 / 0.03				PO₄ 0.78	260[d]		147			
2/19/64 1605	8	53	10.7	98	417	8.0 / 7.9	3.02[a]				0 / 0.00	130 / 2.13		22 / 0.62	1.3 / 0.02				PO₄ 0.77; C=0	265[d]		151			
3/25/64 1240	8	51	11.8	106	415	8.1 / 7.8	3.02[a]				0 / 0.00	131 / 2.15		22 / 0.62	2.2 / 0.04				PO₄ 0.77; SS 15	265[d]		151		4.4	
4/22/64 1135	6	53	11.2	103	382	8.1 / 7.7	2.64[a]				0 / 0.00	126 / 2.06		22 / 0.62	1.8 / 0.03				PO₄ 1.1; Fe 0.24; SS 84	245[d]		132		33	
5/13/64 1100	8	55	10.6	100	402	8.1 / 8.1	2.84[a]				0 / 0.00	134 / 2.20		25 / 0.70	1.0 / 0.02				PO₄ 0.88	260[d]		142		3.5	
6/23/64 1210	7	68	9.5	104	404	7.8 / 8.2	2.84[a]		24 / 1.04		0 / 0.00	136 / 2.23		28 / 0.79	1.6 / 0.03				PO₄ 0.90	260[d]		142		3.0	
7/22/64 0750	8	59	9.9	98	397	7.7 / 8.2	2.76				0 / 0.00	132 / 2.16		27 / 0.76	1.1 / 0.02				PO₄ 0.93	255[d]		138		1.5	
8/17/64 1530	8	66	9.5	102	412	8.2								30 / 0.85	1.5 / 0.02				PO₄ 0.94; ABS 0.0	265[d]				2.9	
9/23/64 1425	8	62	9.7	99	386	8.0	2.78[a]							29 / 0.82	2.3 / 0.04				PO₄ 1.0	240[d]		139		1.2	

Mineral constituents in parts per million / equivalents per million

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

San Lorenzo River at Big Trees (Sta. 31)
10S/2W-27J

Date and time sampled P.S.T	Measured Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e]
							Mineral constituents in parts per million / equivalents per million																		
8/28/63 1420	32	73			377	7.8 / 8.1	46 / 2.30	5.4 / 0.44	22 / 0.96	2.2 / 0.06	0 / 0.00	141 / 2.31	38 / 0.79	21 / 0.59	0.5 / 0.01	0.3 / 0.02	0.09	26	PO_4 0.56, Fe 0.18; ABS 0.0, C=10	232[c]	26	137	21		DWR
10/8/63 1430	12	60	9.7	97	386	8.0														240[d]					
11/7/63 1505	56	52	9.4	85	349	7.7														215[d]					
12/11/63 0910	51	40	11.8	91	361	7.7														220[d]					
1/15/64 1400	34	45	13.3	110	383	7.9														235[d]					
3/25/64 1515	56	53	11.2	103	357	7.5 / 7.6	2.58[a]				0 / 0.00	119 / 1.95		17 / 0.48	1.1 / 0.02				PO_4 0.31	220[d]		129		5.0	
4/22/64 1430	33	59	10.4	103	382	8.0 / 7.7	2.74[a]				0 / 0.00	132 / 2.16		21 / 0.59	0.3 / 0.00				PO_4 0.45	235[d]		137		7.5	
5/13/64 1515	27		10.1		386	8.2 / 8.1	2.82[a]				0 / 0.00	138 / 2.26		21 / 0.59	0.6 / 0.01				PO_4 0.39	240[d]		141		2.8	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C1
ANALYSES OF SURFACE WATER

Date and time sampled	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO3)	Bicarbonate (HCO3)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Fluoride (F)	Boron (B)	Silica (SiO2)	Other constituents	Total dissolved solids in ppm	Per cent sodium	Hardness as CaCO3 Total ppm	Hardness as CaCO3 N.C. ppm	Turbidity in ppm	Coliform[d] MPN/ml	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																			
							San Lorenzo River near Big Trees																			
1951																										
Dec 19 1000	127	50	13.3	117	282	7.2						98/1.61		15/0.42								102		25-		DWR
1952																										
Jan 17 0900	1460	48	11.2	96	196	7.1					0/0.00	64/1.05		7/1.97								70		130		DWR
Feb 19 1530	269	49	11.8	103	295	7.3			15/0.65		0/0.00	102/1.67		6.5/0.183							22	116	32	15		USGS
Mar 18 0900	957	49	11.0	96	249	7.5			12/0.52		0/0.00	82/1.34		10/0.28							22	95	28	40		USGS
Apr 22 0830	150	51	10.5	94	296	7.6					0/0.00	115/1.88		13/0.37								124		2		DWR
May 19 1550	86	63	11.2	116	330	7.8	37/1.85	7.5/0.617	15/0.65	2.0/0.051	0/0.00	117/1.92	42/0.87	16/0.45	0.3/0.005	0.1/0.005	0.07	25	(a) Sn 0.00	203[b]	21	123	27			USGS
Jun 17 1030	70	55	10.0	94	327	8.1					0/0.00	130/2.13		18/0.54								132		8		DWR
Jul 15 0800	16	62	8.8	89	346	7.7					0/0.00	134/2.20		20/0.56								136		2		DWR
Aug 19 0700	30	55	8.5	80		8.0																				DWR
Sep 18 1425	26	63	10.8	110	323	8.2					0/0.00	128/2.10		19/0.54								120				USGS
Oct 21 1000	25	53	10.6	97	331	7.9	38/1.90	6.9/0.567	21/0.91	1.8/0.046	0/0.00	130/2.13	30/0.62	24/0.67	0.2/0.003	0.2/0.011	0.08	25	As 0.05 (a)	211[b]	27	123	17			USGS
Nov 13 1000	23	52	10.0	90	338	7.5					0/0.00	128/2.10		20/0.56								118		3		DWR
Dec 17 1400	75	46	10.5	88	343	7.7					0/0.00	113/1.85		20/0.56								128		3	96 .62-7000	DWR

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and chromium (Cr), reported here as 0.0/0.00 except as shown.

b Determined by addition of analyzed constituents

c Gravimetric determination.

d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif. Dept of Public Health, Division of Laboratories.

e Mineral analyses made by USGS, Quality of Water Branch (USGS), Pacific Chemical Consultant (PCC), Metropolitan Water District (MWD), Los Angeles Dept. of Water & Power (LADWP), City of Los Angeles Dept of Pub Health (LADPH), Long Beach Dept of Pub Health (LBDPH) or State Division of Water Resources (DWR), as indicated

TABLE 01
ANALYSES OF SURFACE WATER

Date and time sampled	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO3)	Bicarbonate (HCO3)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Fluoride (F)	Boron (B)	Silica (SiO2)	Other constituents	Total Dissolved solids in ppm	Percent sodium	Hardness as CaCO3 Total ppm	Hardness as CaCO3 N C ppm	Turbidity in ppm	Coliform[d] MPN/ml	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																			
San Lorenzo River near Big Trees																										
1953																										
Jan 21 0900	344	52	10.0	90	265	7.8	27/1.35	7.9/0.650	14/0.61	1.4/0.036	0/0.00	86/1.41		12/0.34							23	100	29			USGS
Feb 17 0900	96	43	10.5	85	342	7.5	38/1.90	8.5/0.699	18/0.78	1.6/0.041	0/0.00	120/1.96		16/0.45							23	130	31			USGS
Mar 26 0925	144	50	10.5	92	320	7.7	34/1.70	8.7/0.715	17/0.74		0/0.00	109/1.79		15/0.42			0.06				23	121	31			USGS
Apr 20 1630	76	57	11.0	106	346	8.1	38/1.90	9.4/0.723	19/0.83		0/0.00	123/2.01		18/0.51			0.06				24	133	33	5		USGS
May 14 0800	61	57	9.8	94	334	7.6	37/1.85	8.0/0.658	20/0.87	2.0/0.051	0/0.00	121/1.98	48/1.00	16/0.45	0.4/0.007	0.1/0.005	0.03	26	Zn 0.02 (a)	215[b]	23	125	26	5		USGS
Jun 19 0740	52	56	10.0	96	344	7.9					0/0.00	130/2.13		18/0.51			0.02				25	130		2		DWR
Jul 15 0700	32	63	9.6	98	321	8.0			20/0.87		0/0.00	126/2.07		22/0.62			0.05				24	134		3		DWR
Aug 19 1050	25	62	9.5	96	334	7.4	38/1.90	7.3/0.600	20/0.87	1.8/0.046	0/0.00	131/2.15		21/0.59			0.00				25	125	17	2		USGS
Sep 25 0830	21	59	8.6	85	332	7.4	37/1.85	7.4/0.608	19/0.83	1.5/0.038	0/0.00	132/2.16	28/0.58	22/0.62	0.2/0.003	0.2/0.011	0.06	26	Al 0.01; Fe 0.12; Zn 0.02 (a)	206[b]	25	123	15	3		USGS
Oct 16 0900	21	50	11.2	99	340	7.6	39/1.95	6.9/0.567	20/0.87	2.0/0.051	0/0.00	136/2.23		23/0.64			0.07				25	126	14	2		USGS
Nov 9 1545	23	50	12.5	110	343	7.3			22/0.96		0/0.00	132/2.16		23/0.64			0.04				27	132		4		DWR
Dec 17 1330	25	48	13.5	126	364	8.0	40/2.00	8.5/0.699	22/0.96	1.7/0.043	0/0.00	137/2.25		23/0.64			0.07				26	135	22	5	6.2 0.23-7000	USGS
1954																										
Jan 15 0830	30	44	10.5	85	363	7.3	40/2.00	8.7/0.715	22/0.96	2.7/0.069	0/0.00	135/2.21		24/0.67			0.04				26	136	25	5		USGS
Feb 16 1320	218	49	11.0	96	282	7.4	32/1.60	6.3/0.518	15/0.65	1.6/0.041	0/0.00	92/1.51		14/0.39			0.10				23	106	30	42		USGS

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and chromium (Cr), reported here as $\frac{00}{000}$ except as shown

b Determined by addition of analysed constituents

c Gravimetric determination.

d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif Dept of Public Health, Division of Laboratories

e Mineral analyses made by USGS, Quality of Water Branch (USGS), Pacific Chemical Consultant (PCC), Metropolitan Water District (MWD), Los Angeles Dept of Water & Power (LADWP), City of Los Angeles Dept of Pub Health (LADPH), Long Beach Dept of Pub Health (LBDPH) or State Division of Water Resources (DWR), as indicated

TABLE C1
ANALYSES OF SURFACE WATER

Date and time sampled	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Coliform[d] MPN/ml	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																			
											San Lorenzo River near Big Trees															
1954 (continued)																										
Mar 9 1400	240	50	10.8	95	256	7.5	26/1.30	5.8/0.477	13/0.57	2.7/0.069	0/0.00	81/1.33		12/0.34			0.09				23	89	22	275		USGS
Apr 14 1100	139	56	10.0	101	339	8.0	38/1.90	8.8/0.724	18/0.78	1.5/0.038	0/0.00	113/1.85		16/0.45			0.05				23	131	38	3		USGS
May 11 1330	73	61	11.0	111	352	8.0	40/2.00	7.7/0.633	18/0.78	1.8/0.046	0/0.00	123/2.01	49/1.02	18/0.51	0.0/0.00	0.2/0.011	0.09	23	Al 0.04; Fe 0.03; Mn 0.01 (a)	218[b]	23	131	31	4		USGS
Jun 15 1225	40	67	10.0	108	356	7.9	40/2.00	8.3/0.683	20/0.87	1.8/0.046	4/0.133	130/2.13		20/0.56			0.07				24	134	21	13		USGS
Jul 21 1120	31	67	11.5	124	348	8.1	37/1.85	8.1/0.666	20/0.87	1.8/0.046	0/0.00	138/2.26		22/0.62			0.05				25	126	12	8		USGS
Aug 19 1300	17	66	9.8	104	334	7.5	37/1.85	6.3/0.518	22/0.96	2.4/0.061	0/0.00	135/2.21		24/0.67			0.11				28	118	8	3		USGS
Sep 21 1100	16	61	10.5	106	345	8.0	39/1.95	6.3/0.514	21/0.091	1.9/0.049	0/0.00	135/2.21	30/0.62	24/0.67	0.5/0.008	0.1/0.005	0.08	26	Al 0.01; Cu 0.01 Zn 0.01 (a)	216[b]	27	123	12	1		USGS
Oct 21 1145	16	54	10.8	101	347	7.9	40/2.00	6.1/0.504	22/0.96	1.9/0.049	0/0.00	136/2.23	29/0.60	25/0.70	0.2/0.003	0.2/0.011	0.06	27	PO_4 0.70	218[b]	27	125	13	1		USGS
Nov 18 1400	40	50	10.7	94	369	7.5	40/2.00	8.3/0.683	22/0.96	2.1/0.054	0/0.00	122/2.00		23/0.64			0.11	25			26	134	34	7		USGS
Dec 16 1330	90	46	10.9	91	345	7.4	38/1.90	8.8/0.724	20/0.87	1.5/0.038	0/0.00	118/1.93		17/0.48			0.03				25	131	34	3	23 .23-500	USGS

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and chromium (Cr), reported here as $\frac{0.0}{0.00}$ except as shown.

b Determined by addition of analyzed constituents

c Gravimetric determination.

d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif. Dept of Public Health, Division of Laboratories

e Mineral analyses made by USGS, Quality of Water Branch (USGS), Pacific Chemical Consultant (PCC), Metropolitan Water District (MWD), Los Angeles Dept of Water & Power (LADWP), City of Los Angeles Dept of Pub Health (LADPH), Long Beach Dept of Pub Health (LBDPH) or State Division of Water Resources (DWR), as indicated

TABLE C1
ANALYSES OF SURFACE WATER

Date and time sampled	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO3)	Bicarbonate (HCO3)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Fluoride (F)	Boron (B)	Silica (SiO2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as CaCO3 Total ppm	Hardness as CaCO3 N.C. ppm	Turbidity in ppm	Coliform[d] MPN/ml	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																			
							San Lorenzo River at Big Trees (near Felton)																			
1955																										
Jan 18 1400	1,100	45	11.5	95	168	7.2	22 / 1.098	1.0 / 0.082	10 / 0.435	2.2 / 0.056	0 / 0.000	52 / 0.852		6.5 / 0.183			0.00				26	59	16	350		USGS
Feb 18 1120	70	51	11.4	102	365	7.8	40 / 1.996	11 / 0.904	21 / 0.913	1.7 / 0.043	0 / 0.000	126 / 2.065		18 / 0.508			0.07				24	145	42	0.6		USGS
Mar 22 1200	55	52	12.3	111	369	8.0	41 / 2.046	8.9 / 0.734	22 / 0.957	1.7 / 0.043	0 / 0.000	130 / 2.131		20 / 0.564			0.00				25	139	32	1		USGS
Apr 26 1230	182	49	10.9	98	293	7.4	22 / 1.098	12 / 0.958	17 / 0.739	1.6 / 0.041	0 / 0.000	95 / 1.557		14 / 0.395			0.10				26	103	25	28		USGS
May 19 1230	51	65	9.2	97	365	7.9	41 / 2.046	9.7 / 0.794	21 / 0.913	2.2 / 0.056	0 / 0.000	136 / 2.229	51 / 1.062	18 / 0.508	0.5 / 0.008	0.1 / 0.005	0.09	22	Fe 0.005; PO4 0.25; (a)	234[b]	24	142	30	5		USGS
Jun 23 1230	27	57	8.8	84	370	7.4	43 / 2.146	6.5 / 0.534	23 / 1.000	1.9 / 0.049	0 / 0.000	140 / 2.294		21 / 0.592			0.08				27	134	19	1		USGS
Jul 21 1115	21	64	10.5	110	354	7.4	39 / 1.946	8.2 / 0.674	21 / 0.913	1.9 / 0.049	0 / 0.000	142 / 2.327		21 / 0.592			0.13				25	131	15	3		USGS
Aug 25 0920	15	58	9.8	95	333	7.6	36 / 1.796	7.6 / 0.624	20 / 0.870	1.6 / 0.041	0 / 0.000	134 / 2.196		22 / 0.620			0.06				26	121	11	4		USGS
Sep 15 1140	15	57	10.6	102	338	7.2	37 / 1.846	6.4 / 0.530	21 / 0.913	1.8 / 0.046	0 / 0.000	130 / 2.131	28 / 0.583	24 / 0.677	0.4 / 0.006	0.2 / 0.011	0.02	28	Fe 0.05; Al 0.03; Cu 0.01; (a)	211[b]	27	119	12	4.0		USGS
Oct 20 1145	17	56	12.0	114	369	7.4	40 / 1.996	8.4 / 0.692	23 / 1.000	1.9 / 0.049	0 / 0.000	141 / 2.311		26 / 0.733			0.08				27	134	18	20		USGS
Nov 23 1145	21	45	10.9	90	379	7.0	41 / 2.046	8.7 / 0.715	25 / 1.088	2.1 / 0.054	0 / 0.000	138 / 2.262		27 / 0.761			0.16				28	138	25	10		USGS
Dec 20 1130	1,320	53	10.0	92	173	6.8	19 / 0.948	3.1 / 0.252	11 / 0.478	2.5 / 0.064	0 / 0.000	48 / 0.787		10 / 0.282			0.21				27	60	21	2400		USGS
																									median 42	
																									minimum .19	
																									maximum 2400	

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), [illegible] orted here [illegible] $\frac{0}{00}$ except as shown
b Determined by addition of analysed constituents
c Gravimetric determination.
d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif. Dept. of Pub. Health, Division of Laboratories.
e Mineral analyses made by USGS, Quality of Water Branch (USGS), Pacific Chemical Consultant (PCC), Metropolitan Water District (MWD), Los Angeles Dept. of Water & Power (LAOWP), City of Los Angeles Dept of Pub Health (LADPH), Long Beach Dept of Pub Health (LBDPH) or State Division of Water Resources (DWR), as indicated

TABLE C1
ANALYSES OF SURFACE WATER

Date and time sampled	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Coliform[d] MPN/ml	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																			
							San Lorenzo River at Big Trees (near Felton)																			
1956																										
Jan 24 1230	603	49	11.1	97	274	7.1	31 / 1.547	6.0 / 0.493	12 / 0.522	2.1 / 0.054	0 / 0.000	93 / 1.524		10 / 0.282			0.09				20	102	26	40		USGS
Feb 15 1120	203	45	12.7	105	320	7.1	37 / 1.846	8.2 / 0.674	16 / 0.696	1.7 / 0.043	0 / 0.000	119 / 1.950		14 / 0.395			0.05				21	126	28	18		USGS
Mar 19 1320	158	51	11.3	101	339	7.0	38 / 1.896	9.5 / 0.784	17 / 0.740	2.5 / 0.064	0 / 0.000	125 / 2.049		14 / 0.395			0.16				21	134	32	10		USGS
Apr 16 1445	97	55	11.2	105	344	7.0	38 / 1.896	8.6 / 0.704	18 / 0.783	1.9 / 0.049	0 / 0.000	138 / 2.262		15 / 0.423			0.07				23	130	17	6		USGS
May 17 0915	76	58	10.2	100	352	7.5	41 / 2.046	9.9 / 0.814	19 / 0.826	2.0 / 0.051	0 / 0.000	139 / 2.278	47 / 0.979	18 / 0.508	0.1 / 0.002	0.2 / 0.011	0.10	24	Fe 0.01; Al 0.05; Cu 0.02; Zn 0.01; PO_4 0.30; (a)	229[b]	22	143	29	3		USGS
June 21 0955	50	63	10.5	108	357	7.5	41 / 2.046	9.4 / 0.774	20 / 0.870	2.0 / 0.051	0 / 0.000	144 / 2.360		18 / 0.508			0.00				23	141	23	5		USGS
July 26 1050	33	66	10.7	114	351	7.7	42 / 2.096	8.1 / 0.664	21 / 0.914	2.2 / 0.056	0 / 0.000	147 / 2.409		20 / 0.564			0.18				25	138	17	1		USGS
Aug 23 0940	24	64	10.1	105	349	7.2	40 / 1.996	8.6 / 0.704	21 / 0.914	2.3 / 0.059	0 / 0.000	145 / 2.377		21 / 0.592			0.00				25	135	16	0.8		USGS
Sept 14 0930	21	58	10.5	102	343	7.7	42 / 2.096	6.4 / 0.524	20 / 0.870	2.0 / 0.051	0 / 0.000	144 / 2.360	33 / 0.687	21 / 0.592	0.3 / 0.005	0.2 / 0.011	0.09	26	Al 0.05; Cu 0.02; Zn 0.01; PO_4 0.70; (a)	222[b]	25	131	13	2		USGS
Oct 10 1330	26	60	11.2	112	374	7.2	42 / 2.096	7.9 / 0.648	23 / 1.000	2.0 / 0.051	0 / 0.000	153 / 2.508		24 / 0.677			0.04				26	137	12	1.0		USGS
Nov 15 1415	25	49	13.2	115	356	7.0	40 / 2.00	8.8 / 0.72	22 / 0.96	1.8 / 0.05	0 / 0.00	145 / 2.38		23 / 0.65			0.10				26	136	17	2.0		USGS
Dec 18 1210	25	44	14.1	115	365	7.9	41 / 2.05	8.1 / 0.67	22 / 0.96	1.7 / 0.04	0 / 0.00	150 / 2.46		23 / 0.65			0.00				26	136	13	2		USGS
																									median 23 minimum .5 maximum 2400	

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and chromium (Cr), reported here as $\frac{0.0}{0.00}$ except as shown.

b Determined by addition of analysed constituents

c Gravimetric determination.

d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif. Dept of Public Health, Division of Laboratories.

e Mineral analyses made by USGS, Quality of Water Branch (USGS), Pacific Chemical Consultant (PCC), Metropolitan Water District (MWD), Los Angeles Dept. of Water & Power (LADWP), City of Los Angeles Dept of Pub Health (LADPH), Long Beach Dept of Pub Health (LBDPH) or State Division of Water Resources (DWR), as indicated

ANALYSES OF SURFACE WATER

Date and time sampled	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH f	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO3)	Bicarbonate (HCO3)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Fluoride (F)	Boron (B)	Silica (SiO2)	Other constituents	Total dissolved solids in ppm b	Percent sodium	Hardness as CaCO3 Total ppm	Hardness as CaCO3 N.C. ppm	Turbidity in ppm	Coliform d MPN/ml	Analyzed by e
							Mineral constituents in parts per million / equivalents per million																			
											SAN LORENZO RIVER AT BIG TREES (STA. 75)															
1957																										
1/17 1130	32	44	12.0	98	371	7.7	42 / 2.10	8.3 / 0.68	22 / 0.96	1.8 / 0.05	0 / 0.00	134 / 2.20		23 / 0.65			0.02				25	139	29	3		USGS
2/21 0955	67	51	10.9	97	241	7.3	25 / 1.25	6.2 / 0.51	16 / 0.70	1.9 / 0.05	0 / 0.00	91 / 1.49		16 / 0.45			0.03				28	88	13	55		USGS
3/11 1340	114	55	9.8	94	337	*7.6	39 / 1.95	7.4 / 0.61	20 / 0.87	1.8 / 0.05	0 / 0.00	113 / 1.85		16 / 0.45			0.00				25	128	35	5		USGS
4/17 1610	106	55	9.8	92	269	7.5	28 / 1.40	6.3 / 0.52	15 / 0.65	1.8 / 0.05	0 / 0.00	95 / 1.56		14 / 0.39			0.16				25	96	18	268		USGS
5/15 0745	57	54	10.3	95	348	7.6	40 / 2.00	7.8 / 0.64	20 / 0.87	1.6 / 0.04	0 / 0.00	132 / 2.16	42 / 0.87	18 / 0.51	0.2 / 0.00	0.3 / 0.02	0.10	21	Fe 0.06 Al 0.10 Cu 0.01 Zn 0.02 PO4 0.35 a	216	25	132	24	2		USGS
6/20 0805	42	60	9.7	97	349	7.9	41 / 2.05	7.3 / 0.60	20 / 0.87	2.0 / 0.05	0 / 0.00	136 / 2.23		18 / 0.51			0.06				24	132	20	1		USGS
7/17 1345	26.6	69	11.2	123	353	8.2			21 / 0.91		6 / 0.20	132 / 2.16		22 / 0.62			0.10		Tot. Alk. 144		25	134	16	0.8		USGS
8/21 1200	19.4	68	9.9	108	347	7.9			21 / 0.91		0 / 0.00	138 / 2.26		25 / 0.71			0.05				26	129	16	0.8		USGS
9/12 1130	18.5	65	9.8	104	351	7.8	40 / 2.00	6.3 / 0.52	22 / 0.96	2.6 / 0.07	0 / 0.00	137 / 2.25	29 / 0.60	25 / 0.70	0.4 / 0.01	0.2 / 0.01	0.00	20	PO4 0.60 Fe 0.02 a	223	27	126	14	10		USGS
10/15 0815	36.0	54	9.9	92	356	7.6			20 / 0.87		0 / 0.00	131 / 2.15		23 / 0.65			0.05				25	131	24	10		USGS
11/20 1240	36.6	55	11.2	105	374	7.9			23 / 1.00		0 / 0.00	146 / 2.39		24 / 0.68		0.10					26	140	20	1		USGS
12/16 1550	1280	53	9.7	89	181	7.3			11 / 0.48		0 / 0.00	57 / 0.93		12 / 0.34		0.09					25	71	24	150	Median 230 Max. 7,000 Min. 2.3	USGS

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and chromium (Cr), reported here as $\frac{0.0}{0.00}$ except as shown.

b Determined by addition of analyzed constituents.

c Gravimetric determination.

d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif. Dept. of Public Health, Division of Laboratories.

e Mineral analyses made by USGS, Quality of Water Branch (USGS), Pacific Chemical Consultant (PCC), Metropolitan Water District (MWD), Los Angeles Dept. of Water & Power (LADWP), City of Los Angeles Dept of Pub. Health (LADPH), Long Beach Dept of Pub Health (LBDPH) or State Department of Water Resources (DWR), as indicated

f Field pH except when noted with ✱

TABLE C1

ANALYSES OF SURFACE WATER

Date and time sampled PST	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH [f]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Coliform [d] MPN/ml	Analyzed by [e]
							Mineral constituents in parts per million / equivalents per million																			
1958																										
							SAN LORENZO RIVER AT BIG TREES (STA. 75)																			USGS
1/23 1210	49	45	12.6	104	371	7.9	—	—	23 / 1.00	---	0 / 0.00	136 / 2.23	---	21 / 0.59	—	—	0.00 / ---	—		—	27	135	23[c]	4	Maximum 7000.+ Minimum 2.3 Median 23.	
2/14 1015	640	53	10.8	99	258	7.3	—	—	13 / 0.57	—	0 / 0.00	86 / 1.41	—	12 / 0.34	—	---	0.04 / ---	—		—	23	98	27	70		
3/13 1135	234	49	10.7	93	299	7.5	—	—	15 / 0.65	—	0 / 0.00	107 / 1.75	---	14 / 0.39	—	—	0.00 / ---	—		—	22	114	26	12		
4/16 1155	403	57	10.3	99	289	7.5	—	—	13 / 0.57	—	0 / 0.00	105 / 1.72	—	13 / 0.37	—	—	0.01 / ---	—		—	20	115	29	15		
5/16 0755	125	57	9.8	94	325	7.9	39 / 1.95	6.9 / 0.57	18 / 0.78	2.1 / 0.05	0 / 0.00	124 / 2.03	41 / 0.85	16 / 0.45	0.0 / 0.00	0.1 / 0.01	0.08 / ---	27 / --	Fe 0.04 Cu 0.05 Zn 0.01 PO_4 0.30 a	211[b]	23	126	24	1		
6/18 1430	71	70	9.1	101	325	7.9	—	—	17 / 0.74	—	0 / 0.00	126 / 2.07	—	16 / 0.45	—	—	0.0 / ---	—		—	23	124	21	5		
7/15 1230	49	66	10.5	112	339	7.9	—	—	19 / 0.83	—	0 / 0.00	135 / 2.21	—	18 / 0.51	—	—	0.0 / ---	—		—	25	126	15	1		
8/12 1320	32	71	10.9	122	332	7.9	—	—	19 / 0.83	—	0 / 0.00	132 / 2.16	—	20 / 0.56	—	—	0.1 / ---	—		—	24	130	22	3		
9/10 0845	28	63	10.0	103	330	8.0	38 / 1.90	6.9 / 0.57	19 / 0.83	2.3 / 0.06	0 / 0.00	133 / 2.18	28 / 0.58	21 / 0.59	0.3 / 0.00	0.2 / 0.01	0.0 / ---	28 / --	Fe 0.02 Al 0.07 PO_4 0.55 Zn 0.04 a	210[b]	25	124	15	2		
10/22 1020	23	54	12.1	112	332	7.8	—	—	20 / 0.87	—	0 / 0.00	133 / 2.18	—	20 / 0.56	—	---	0.0 / ---	—		—	26	124	15	5		
11/18 1630	25	46	12.3	103	343	7.4	—	—	21 / 0.91	—	0 / 0.00	134 / 2.20	---	22 / 0.62	—	---	0.0 / ----	—		—	25	134	24	3		
12/9 0930	23	45	11.9	98	352	7.3	—	—	21 / 0.91	—	0 / 0.00	137 / 2.25	---	22 / 0.62	—	—	0.1 / ---	—		—	26	132	20	10		

a Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and hexavalent chromium (Cr^{+6}), reported as $\frac{0.0}{0.00}$ except as shown.
b Determined by addition of analyzed constituents.
c Gravimetric determination.
d Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by Calif. Dept. of Public Health, Division of Laboratories, or United States Public Health Service
e Mineral analyses made by USGS, Quality of Water Branch (USGS), United States Public Health Service (USPHS), San Bernardino County Flood Control District (SBCFCD), Metropolitan Water District (MWD), Los Angeles Dept. of Water & Power (LADWP), City of Los Angeles Dept. of [illegible]

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER AT BIG TREES NEAR FELTON (STA. 75)

Date and time sampled P.S.T.	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH[a]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO3)	Bicarbonate (HCO3)	Sulfate (SO4)	Chloride (Cl)	Nitrate (NO3)	Fluoride (F)	Boron (B)	Silica (SiO2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as CaCO3 Total ppm	Hardness as CaCO3 N.C. ppm	Turbidity in ppm	Coliform[h] MPN/ml	Analyzed by[i]
							Mineral constituents in parts per million / equivalents per million																			
1959																										USGS
1/7 1550	85	50	10.7	95	311	7.3	2.28[c]		19 / 0.83		0.0 / 0.00	88 / 1.44		20 / 0.56			0.0			189[e]	27	114	42	50	Median 23	
2/9 1130	56	45	11.3	93	348	7.4	2.64[c]		19 / 0.83		0.0 / 0.00	125 / 2.05		22 / 0.62			0.0			211[e]	24	132	30	1	Maximum 7.000	
3/4 1430	58	54	10.1	94	336	7.4	2.57[c]		17 / 0.74		0.0 / 0.00	113 / 1.85		16 / 0.45			0.0			204[e]	22	129	36	4	Minimum 1.3	
4/1 1030	62	56	10.3	98	352	7.4	2.68[c]		19 / 0.83		0.0 / 0.00	126 / 2.07		17 / 0.48			0.0			214[e]	24	134	31	1		
5/13 0735	35	57	9.2	88	355	7.5	40 / 2.00	8.5 / 0.70	21 / 0.91	1.8 / 0.05	0.0 / 0.00	137 / 2.25	40 / 0.83	20 / 0.56	0.4 / 0.01	0.1 / 0.01	0.0	20	Fe 0.03 Al 0.08 Zn 0.01 PO4 0.45[d]	219[f]	25	135	23	2		
6/8 1000	29	60	9.7	97	352	7.3	2.68[c]		22 / 0.96		0.0 / 0.00	138 / 2.26		23 / 0.65			0.0			214[e]	26	134	21	10		
7/2 0900	22	64	9.4	98	350	7.4	2.60[c]		22 / 0.96		0.0 / 0.00	139 / 2.28		21 / 0.59			0.1			212[e]	27	130	16	2		
8/3 1030	18	64	10.7	112	333	7.9	2.48[c]		21 / 0.91		0.0 / 0.00	135 / 2.21		22 / 0.62			0.1			202[e]	27	124	13	1		
9/8 1630	15	67	9.2	99	341	7.8	39 / 1.95	6.9 / 0.57	21 / 0.91	2.1 / 0.05	0.0 / 0.00	134 / 2.20	24 / 0.50	25 / 0.70	0.7 / 0.01	0.1 / 0.01	0.1	27	PO4 0.70 Cu 0.01[d]	212[f]	26	126	16	2		
10/6 1600	2[illegible]	59	10.3	102	371	7.5	2.80[c]		26 / 1.13		0.0 / 0.00	140 / 2.29		32 / 0.90			0.1			225[e]	29	140	25	1		
11/3 1520	21	53	11.8	108	370	7.9	2.74[c]		25 / 1.09		0.0 / 0.00	150 / 2.46		25 / 0.70			0.1			225[e]	28	137	14	1		
12/8 1145	19	43	13.8	111	380	7.9	2.74[c]		28 / 1.22		0.0 / 0.00	145 / 2.38		28 / 0.79			0.0			231[e]	31	137	18	3		

a Field pH.

b Laboratory pH.

c Sum of calcium and magnesium in epm.

d Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and hexavalent chromium (Cr^{+6}), reported here as $\frac{0.0}{0.00}$ except as shown

e Derived from conductivity vs TDS curves

f Determined by addition of analyzed constituents

g Gravimetric determination

h Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by California Department of Public Health, Division of Laboratories, or United States Public Health Service

i Mineral analyses made by United States Geological Survey, Quality of Water Branch (USGS); United States Department of the Interior, Bureau of Reclamation (USBR); United States Public Health Service (USPHS), San Bernardino County Flood Control District (SBCFCD), Metropolitan Water District of Southern California (MWD), Los Angeles Department of Water and Power (LADWP), City of Los Angeles, Department of Public Health (LADPH), City of Long Beach, Department of Public Health (LBDPH), Terminal Testing Laboratories, Inc. (TTL); or California Department of Water Resources (DWR), as indicated

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER AT BIG TREE NEAR FELTON (STA. 75)

Date and time sampled P.S.T.	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH[a]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Coliform[h] MPN/ml	Analyzed by[i]
							Mineral constituents in parts per million / equivalents per million																			
1960																										USGS
1/12 1530	78	46	10.4	88	334	7.3	2.44[c]		23/1.00		0.0/0.00	103/1.69		23/0.65			0.1			203[e]	29	122	38	75	Median 6.2	
2/3 1500	232	50	10.5	94	266	7.3	2.10[c]		15/0.65		0.0/0.00	83/1.36		22/0.62			0.0			162[e]	24	105	37	60	Maximum 2,400.	
3/2 1415	61	52	10.5	96	356	7.4	2.66[c]		20/0.87		0.0/0.00	126/2.07		19/0.54			0.0			216[e]	25	133	30	6	Minimum 2.3	
4/12 1455	40	62	10.4	107	360	7.7	2.60[c]		23/1.00		0.0/0.00	136/2.23		23/0.65			0.0			219[e]	28	130	18	15		
5/3 1250	45	56	10.6	101	341	7.5	41/2.05	6.4/0.53	22/0.96	2.5/0.06	0.0/0.00	132/2.16	40/0.83	20/0.56	0.3/0.00	0.1/0.01	0.1	24	Fe 0.14, Al 0.15, Cu 0.06, PO_4 0.50[d], Zn 0.02	222[f]	27	129	21	8		
6/7 1335	23	72	10.2	117	353	8.0	2.60[c]		23/1.00		0.0/0.00	145/2.38		26/0.73			0.1			215[e]	28	130	11	1		
7/12 1200	15	71	10.5	119	367	7.9	2.70[c]		24/1.04		0.0/0.00	151/2.47		24/0.68			0.0			223[e]	28	135	11	3		
8/2 1450	11	77	9.0	108	340	7.7	2.52[c]		22/0.96		0.0/0.00	140/2.29		35/0.99			0.0			207[e]	28	126	11	3		
9/6 1430	10	69	9.6	107	340	8.0	38/1.90	7.9/0.65	22/0.96	1.7/0.04	0.0/0.00	144/2.36	32/0.67	20/0.56	0.0/0.00	0.1/0.01	0.1	28	Fe 0.01, PO_4 0.75[d]	221[f]	27	127	9	[illegible]		
10/4 1440	13	62	9.8	101	346	7.7	2.36[c]		23/1.00		0.0/0.00	128/2.10		26/0.73			0.1			210[e]	30	118	13	25		
11/8 1320	14	55	12.3	117	393	7.9	2.88[c]		25/1.09		0.0/0.00	148/2.43		34/0.96			0.1			239[e]	27	144	23	1		
12/13 1215	25	46	11.1	94	395	7.6	2.90[c]		27/1.17		0.0/0.00	110/1.80		27/0.76			0.1			240[e]	29	145	55	5		

a Field pH.

b Laboratory pH.

c Sum of calcium and magnesium in epm.

d Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and hexavalent chromium (Cr^{+6}), reported here as $\frac{0.0}{0.00}$ except as shown.

e Derived from conductivity vs TDS curves.

f Determined by addition of analyzed constituents.

g Gravimetric determination.

h Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by California Department of Public Health, Division of Laboratories, or United States Public Health Service.

i Mineral analyses made by United States Geological Survey, Quality of Water Branch (USGS); United States Department of the Interior, Bureau of Reclamation (USBR); United States Public Health Service (USPHS); San Bernardino County Flood Control District (SBCFCD); Metropolitan Water District of Southern California (MWD), Los Angeles Department of Water and Power (LADWP), City of Los Angeles, Department of Public Health (LADPH), City of Long Beach, Department of Public Health (LBDPH); Terminal Testing Laboratories, Inc. (TTL), or California Department of Water Resources (DWR); as indicated.

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TABLE C1
ANALYSES OF SURFACE WATER

SAN LORENZO RIVER AT BIG TREES (STA. 75)

Mineral constituents in parts per million / equivalents per million

Date and time sampled P.S.T.	Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH[a]	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Coliform[h] MPN/ml	Analyzed by[i]
1961																										USGS
1/10 1400	19	48	13.6	118	395	8.3	2.82[c]		33 1.44		0.0 0.00	143 2.34		26 0.73			0.1			240[e]	34	141	24	6	Median 6.2	
2/14 1450	46	53	11.0	102	380	7.7	2.68[c]		28 1.22		0.0 0.00	128 2.10		23 0.65			0.1			231[e]	31	134	29	10	Maximum 230.	
3/7 1430	29	55	11.5	109	374	7.7	2.69[c]		25 1.09		0.0 0.00	132 2.16		24 0.68			0.1			227[e]	29	135	27	8	Minimum 1.3	
4/11 1600	29	62	9.2	95	399	7.7	2.96[c]		24 1.04		0.0 0.00	143 2.34		25 0.70			0.3			242[e]	26	148	31	4		
5/2 1245	23	67	10.7	117	385	8.1	44 2.20	7.8 0.64	26 1.13	1.5 0.04	3 0.10	136 2.23	41 0.85	26 0.73	1.0 0.02	0.2 0.01	0.1	21	Fe 0.01 PO_4 0.35 d Al 0.02 Tot. Alk. 142	239[f]	28	142	26	6		
6/6 1415	20	75	10.9	130	385	8.3	2.78[c]		25 1.09		4 0.13	137 2.25		27 0.76			0.1		Tot. Alk. 145	234[e]	28	139	20	1		
7/11 1035	9.5	72	9.0	105	368	7.9	2.76[c]		25 1.09		0.0 0.00	140 2.29		25 0.70			0.1			224[e]	28	138	23	5		
8/4 0800	9.0	63	8.9	93	350	7.6	2.56[c]		23 1.00		0.0 0.00	135 2.21		27 0.76			0.0			212[e]	28	128	17	2		
9/12 0715	9.4	58	8.8	87	343	7.7	38 1.90	6.8 0.56	21 0.91	1.5 0.04	0.0 0.00	132 2.16	30 0.62	24 0.68	0.5 0.01	0.2 0.01	0.0	32	Fe 0.26 PO_4 0.60 Zn 0.03	219[f]	27	123	15	4		
10/5 1215	11.0	62	10.2	105	347	8.0	2.50[c]		22 0.96		0.0 0.00	134 2.20		24 0.68			0.1			211[e]	28	125	15	5		
11/8 1055	11.0	47	11.3	96	393	7.6	2.80[c]		26 1.13		2 0.07	139 2.28		34 0.96			0.0		Tot. Alk. 143	239[e]	29	140	23	3		
12/6 1345	28	50	10.1	90	433	7.2	3.18[c]		26 1.13		0.0 0.00	125 2.05		31 0.87			0.1			263[e]	26	159	57	10		

a Field pH.

b Laboratory pH.

c Sum of calcium and magnesium in epm.

d Iron (Fe), aluminum (Al), arsenic (As), copper (Cu), lead (Pb), manganese (Mn), zinc (Zn), and hexavalent chromium (Cr^{+6}), reported here as $\frac{0.0}{0.00}$ except as shown.

e Derived from conductivity vs TDS curves

f Determined by addition of analyzed constituents.

g Gravimetric determination.

h Annual median and range, respectively. Calculated from analyses of duplicate monthly samples made by California Department of Public Health, Division of Laboratories, or United States Public Health Service.

i Mineral analyses made by United States Geological Survey, Quality of Water Branch (USGS); United States Department of the Interior, Bureau of Reclamation (USBR); United States Public Health Service (USPHS); San Bernardino County Flood Control District (SBCFCD); Metropolitan Water District of Southern California (MWD); Los Angeles Department of Water and Power (LADWP); City of Los Angeles, Department of Public Health (LADPH); City of Long Beach, Department of Public Health (LBDPH); Terminal Testing Laboratories, Inc. (TTL); or California Department of Water Resources (DWR); as indicated.

TABLE C1

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

San Lorenzo River at Check Dam (Sta. 33)
11S/2W-12F

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents [b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by [e]
							Mineral constituents in parts per million / equivalents per million																		
3/30/49	190				309		36 / 1.79	9.4 / 0.77	17 / 0.76			103 / 1.69	54 / 1.13	15 / 0.43			0.03			190[d]	22	128			DWR
9/12/58	30				313	/ 8.0								21 / 0.59					Fe 0.17 Mn 0.00	195		123			Brown & Caldwell
10/7/59	25				344	/ 8.3								23 / 0.65					Fe 0.18 Mn 0.00	215[d]		131			Brown & Caldwell
7/28/60	10				343	/ 7.7								24 / 0.68						215[d]		132			Brown & Caldwell
6/26/62	20				378	/ 8.3	46 / 2.28	9.2 / 0.76	23 / 1.00	2.6 / 0.07	12 / 0.40	117 / 1.92	59 / 1.24	22 / 0.62	0.5 / 0.01			17	Fe 0.07 Mn < 0.01	238[c]		152			Brown & Caldwell
8/28/63 1315	35	70			376	8.3 / 8.2	40 / 2.00	11 / 0.88	21 / 0.91	2.3 / 0.06	0 / 0.00	141 / 2.31	42 / 0.87	21 / 0.59	0.4 / 0.01	0.2 / 0.01	0.10	24	PO_4 0.46 Fe 0.01 ABS 0.0 C=10	232[c]	24	144	28		DWR
10/10/63 1600	15	62	11.3	115	388	8.3 / 7.9	2.82		23 / 1.00		0 / 0.00	141 / 2.31		22 / 0.62	0.9 / 0.01				PO_4 0.53 Fe 0.40	240[d]		141			DWR
11/5/63 1625	150	56	9.6	91	331	7.4 /	2.34[a]		19 / 0.83		0 / 0.00	112 / 1.84		19 / 0.54	1.2 / 0.02				PO_4 0.70 ABS 0.0	205[d]		117			DWR
12/11/63 0840	50	40	12.5	96	380	7.7 /									0.9 / 0.01				PO_4 0.41	235[d]					DWR
1/16/64 0900	35	39	12.7	96	390	7.7 / 8.0	2.90[a]				0 / 0.00	134 / 2.20		22 / 0.62	0.4 / 0.01				PO_4 0.28	240[d]		145			DWR
2/20/64 1430	50	55	13.2	124	382	7.9 / 8.1	2.84[a]				0 / 0.00	132 / 2.16		19 / 0.54	1.5 / 0.02				PO_4 0.32 Color 0	235[d]		142			DWR
3/26/64 1400	50	59	12.6	124	364	8.4 / 8.0	2.68[a]				0 / 0.00	125 / 2.05		18 / 0.51	0.8 / 0.01				PO_4 0.32	225[d]		134		3.4	DWR
4/23/64 1430	30	60	12.2	122	389	8.4 / 8.3	2.84[a]				0 / 0.00	138 / 2.26		22 / 0.62	0.1 / 0.00				PO_4 0.37	240[d]		142		2.6	DWR
5/14/64 1340	25		10.6		389	8.4 / 8.3	2.84[a]				0 / 0.00	141 / 2.31		22 / 0.62	0.3 / 0.00				PO_4 0.41	240[d]		142		2.3	DWR
6/23/64 0920	20	67	9.1	98	387	7.5 / 8.2	2.86[a]		21 / 0.91		0 / 0.00	144 / 2.36		23 / 0.65	0.9 / 0.01				PO4 0.41	240[d]		143		1.5	DWR
7/22/64 1200	27	74	9.9	115	386	7.6 / 8.2	2.80[a]				0 / 0.00	143 / 2.34		24 / 0.68	1.2 / 0.02				PO_4 0.46	240[d]		140		0.9	DWR

a Sum of calcium and magnesium in epm
b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).
c Gravimetric determination
d Derived from conductivity vs TDS curves.
e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo River at Check Dam (Sta. 33)
11S/2W-12F

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/4/64 0530															0.0 / 0.00				NH_4 0.00; NO_2 0.00; Organic Nitrogen 0.1; 5-day B.O.D. 0.6						
8/4/64 0540	25																		BHC isomer < 5 ppt; Lindane < 5 ppt; pp DDE < 5 ppt; Dieldrin < 10 ppt; pp DDD < 10 ppt; pp DDD < 10 ppt						
8/17/64 1445	25	76	11.2	133	380	8.4								23 / 0.65	0.3 / 0.00				PO_4 0.59; ABS 0.0	235[d]				0.7	
9/24/64 0800	25	60	8.2	82	389	7.6	2.70[a]							51 / 1.44	0.6 / 0.01				PO_4 0.50	240[d]		135		2.0	

a Sum of calcium and magnesium in epm
b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).
c Gravimetric determination
d Derived from conductivity vs TDS curves
e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo Water Before Treatment

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field	pH Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Alkalinity as $CaCO_3$	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e]
								Mineral constituents in parts per million / equivalents per million																		
4/17/63							7.9								15					84			112		30	SC
5/15/63							7.9								18					100			135		3.0	
6/19/63							8.0								21					120			142		2.5	
7/17/63							7.3								21					126			137		1.5	
8/31/63							8.2								22					126			138		1.5	
9/30/63							8.1								25					124			136		0.8	
10/31/63							8.2								25					126			137		2.0	
11/30/63							7.6								14					84			82		9.0	
12/31/63							7.5								22					122			88		1.5	
1/31/64							7.6								20					60			67		1.3	
2/29/64							8.4								20					104			142		0.8	
3/31/64							7.1								21					116			134		0.8	
4/30/64							7.9								22					116			133		0.4	
5/31/64							8.0								25					128			139		0.3	
6/30/64							8.1								20.5					120			141		1.6	
7/31/64							8.2								20					122			135		1.5	
8/31/64							8.1								24					120			133		1.0	
9/30/64							7.7								23					120			131		0.8	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

San Lorenzo River Water Before Treatment

Date and time sampled P.S.T	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen		Specific conductance (micromhos at 25°C)	pH		Mineral constituents in parts per million / equivalents per million														Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$		Turbidity in ppm	Analyzed by[e]
			ppm	%Sat		Field	Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Alkalinity as $CaCO_3$				Total ppm	N C ppm		SC
11/22/61	20						7.8								37					120				141		4.0	
12/20/61	20						7.9								33					118				150		2.0	
1/25/62	30						7.8								29					110				143		8.0	
2/21/62	330						7.7								17					74				105		30	
3/21/62	130						7.8								11					70				129		5.0	
4/21/62	50						8.0								24					112				144		2.0	
5/16/62	30						7.7								26					120				140		2.0	
6/20/62	20						8.1								27					120				138		2.0	
7/18/62	15						8.1								28					118				142		2.0	
8/13/62	15						8.0								28					122				142		1.5	
9/19/62	15						8.1								29					125				149		3.0	
10/17/62							7.9								22					100				134		4.0	
11/21/62							8.1								26					128				148		1.0	
12/26/62							8.1								24					120				150		1.5	
1/17/63							8.1								26					124				157		1.5	
2/20/63							8.1								17					100				132		10	
3/20/63							8.1								16					106				135		6.0	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves.

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated.

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED -- SANTA CRUZ COUNTY

Branciforte Creek Above confluence with Carbonera Creek (Sta. 34)
11B/1W-7F

Date and time sampled PST	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field Lab	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N C ppm	Turbidity in ppm	Analyzed by[e] DWR
11/6/63 0735	8	54	10.3	96	351	7.2 7.1	1.98[a]		18 0.78		0 0.00	56 0.92		25 0.70	13 0.21		0.1		PO_4 1.1 ABS 0.0			99			
12/13/63 0845	3	38	12.0	90	583	7.9 8.1	4.52[a]		33 1.44		0 0.00	228 3.74		31 0.87	1.9 0.03				PO_4 0.48			226			
1/16/64 1040	1-1/2	40	14.2	109	614	8.2 8.2	4.84[a]				0 0.00	252 4.13		32 0.90	0.6 0.01				PO_4 0.39 ABS 0.0			242			
3/26/64 1500	5	55			493	8.3 7.9	3.64[a]				0 0.00	179 2.93		28 0.79	3.0 0.05				PO_4 0.68			182		13	
5/14/64 1430	1-1/2	58	11.0	107	641	8.2 8.2	4.96[a]				0 0.00	263 4.31		35 0.99	1.7 0.03				PO_4 0.67			248		15	
6/23/64 0730	1	58	8.9	87	669	7.6 8.3	5.17[a]		41 1.78		0 0.00	284 4.65		36 1.02	2.0 0.03				PO_4 0.78			259		3.5	
7/22/64 1230	1/2	65	10.8	114	678	7.6 8.5	5.31[a]				8 0.27	276 4.52		37 1.04	1.0 0.02				PO_4 0.79			266		3.4	
8/17/64 1405	3/4	65	11.4	120	677	8.4								36 1.02	0.6 0.01				PO_4 0.80 ABS 0.0					2.4	
9/23/64 1010	3/4	60	9.3	93	702	8.0	5.55[a]							39 1.10	3.0 0.05				PO_4 0.93			278		2.1	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C)

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED – SANTA CRUZ COUNTY

Carbonera Creek (Sta 35)
11S/1W-7E

Date and time sampled P.S.T.	Estimated Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e] DWR
1/16/64 1020	2	40	13.4	103	312	7.3																			
2/20/64 1345	2	53			315	7.3 / 7.6	2.00[a]				0 / 0.00	78 / 1.28		22 / 0.62	4.4 / 0.07				PO_4 0.42 C=10			100			
3/26/64 1500	2-1/2				320																				
5/14/64 1455	3/4	61	10.0	101	314	7.4 / 7.9	1.82[a]				0 / 0.00	86 / 1.41		23 / 0.65	2.0 / 0.03				PO_4 0.46			91		4.0	
6/23/64 0750	1/2	58	9.0	88	325	7.2 / 7.7	1.88[a]		24 / 1.04		0 / 0.00	87 / 1.42		26 / 0.73	2.0 / 0.03				PO_4 0.52			94		3.5	
7/22/64 1220	1/4	66	9.9	106	330	7.4 / 7.9	1.76[a]				0 / 0.00	89 / 1.46		28 / 0.79	1.2 / 0.02				PO_4 0.52			88		2.3	
8/17/64 1350	1/4	67	9.4	102	350	7.2								31 / 0.87	0.9 / 0.01				PO_4 0.56 ABS 0.0					1.5	
9/23/64 1000	1/4	60	7.8	78	383	7.3	1.96[a]							38 / 1.07	1.4 / 0.02				PO_4 0.64			98		3.6	

a Sum of calcium and magnesium in epm
b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).
c Gravimetric determination
d Derived from conductivity vs TDS curves
e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE CI

ANALYSES OF SURFACE WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Branciforte Creek at Market Street Bridge (Sta. 36)
11S/1W-7M

Date and time sampled P.S.T.	Measured Discharge in cfs	Temp in °F	Dissolved oxygen ppm	Dissolved oxygen %Sat	Specific conductance (micromhos at 25°C)	pH Field / Lab	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[b]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$ Total ppm	Hardness as $CaCO_3$ N.C. ppm	Turbidity in ppm	Analyzed by[e]
							Mineral constituents in parts per million / equivalents per million																		DWR
8/28/63 1240	1.7	63			559	8.1 / 8.2	66 / 3.29	10 / 0.85	37 / 1.61	3.1 / 0.08	0 / 0.00	226 / 3.70	55 / 1.14	32 / 0.90	0.9 / 0.01	0.4 / 0.02	0.13	32	PO_4 0.67, Fe 0.01, ABS 0.0, C=25	390[c]	28	207	22		
10/7/63 1330	1.4	63	10.5	109	547	8.2 / 8.0	3.96[a]		40 / 1.74		0 / 0.00	213 / 3.49		32 / 0.90	1.2 / 0.02				PO_4 0.71, Fe 0.50	380[d]		198			
11/6/63 0735	15	54	9.3	86	356	7.4 / 7.4	2.32[a]		22 / 0.96		0 / 0.00	89 / 1.46		25 / 0.70	5.5 / 0.09		0.1		PO_4 0.90, Fe 0.88, ABS 0.0	250		116			
12/10/63 0800	5.6	42	10.9	86	356	7.2									5.8 / 0.09				PO_4 0.44	250[d]					
1/16/64 0950	3.2	40	13.4	103	486	8.1 / 8.1	3.50[a]				0 / 0.00	174 / 2.85		28 / 0.79	1.9 / 0.03				PO_4 0.34, ABS 0.0	340[d]		175			
2/20/64 1400	4.2	54			417	8.0 / 7.9	2.92[a]				0 / 0.00	138 / 2.26		25 / 0.70	3.4 / 0.05				PO_4 0.45, C=5	290[d]		146			
3/26/64 1430	7.7	56	11.1	66	416	8.0 / 7.6	2.86[a]				0 / 0.00	129 / 2.11		26 / 0.73	4.9 / 0.08				PO_4 0.54	290[d]		143		13	
4/23/64 1515	3.2	54	11.3	105	497	8.4 / 8.1	3.56[a]				0 / 0.00	180 / 2.95		29 / 0.82	1.5 / 0.02				PO_4 0.50	345[d]		178		4.5	
5/14/64 1410	2.4	60	11.0	110	526	8.1 / 8.3	3.86[a]				0 / 0.00	200 / 3.28		35 / 0.99	1.5 / 0.02				PO_4 0.42	370[d]		193		5.0	
6/23/64 0700	1.4	58	8.7	85	572	7.8 / 8.2	4.24[a]		18 / 0.78		0 / 0.00	225 / 3.69		34 / 0.96	1.1 / 0.02				PO_4 0.67	400[d]		212		3.0	
7/22/64 1215	0.8	67	10.7	116	580	7.9 / 8.3	4.24[a]				0 / 0.00	229 / 3.75		34 / 0.96	1.4 / 0.02				PO_4 0.68	405[d]		212		3.3	
8/17/64 1350	1.2	66	10.6	113	611	8.4								37 / 1.04	0.4 / 0.01				PO_4 0.74, ABS 0.0	425[d]				1.9	
9/24/64 0945	0.9	61	9.1	92	668	7.9	5.09[a]							39 / 1.10	2.1 / 0.03				PO_4 0.89	465[d]		255		4.0	

a Sum of calcium and magnesium in epm

b Iron (Fe), manganese (Mn), total phosphate (PO_4), alkyl benzene sulfonate detergent (ABS), suspended solids (SS), and color (C).

c Gravimetric determination

d Derived from conductivity vs TDS curves

e Department of Water Resources (DWR), Brown and Caldwell (B&C), or City of Santa Cruz (SC), as indicated

TABLE C2

COLIFORM ANALYSES OF SURFACE WATER
April 9 to October 19, 1964
SAN LORENZO RIVER WATERSHED, SANTA CRUZ COUNTY

Sampling Station	Most Probable Number per 100 ml														
	4/6	4/20	5/4	5/18	6/8	6/22	7/6	7/20[a]	8/3	8/17[a]	8/31	9/14	9/28	10/5	10/19
2	23		2400		62		230		2400		230		7000		230
3	500		62		62		500		230		62		130		230
4	230		620		130		230		2400		2400		620		620
5	230		620		620		2400		230		7000		7000		7000
6	50		1300		620		230		7000		7000		77000		620
9	130		230		62		23		1300		130		620		23
11	230		620		7000		230		230		23		620		620
14	230		62		7000		230		620		620		620		230
15		130		230		23		620		$2.4X10^6$		7000		50	
19		62		620		230		2300		6200		230		62	
20		620		1000		7000		500		23000		-		7000	
22		62		230		230		62000		23000		620		620	
23		130		130		230		130		45		2400		620	
29		2400		230		2400		6200		620		620		620	
32		120		62		230		620		$2.4X10^6$		130		230	
33		23		23		230		45		210000		21		230	

a. Sample analyses made by State Department of Public Health, Berkeley

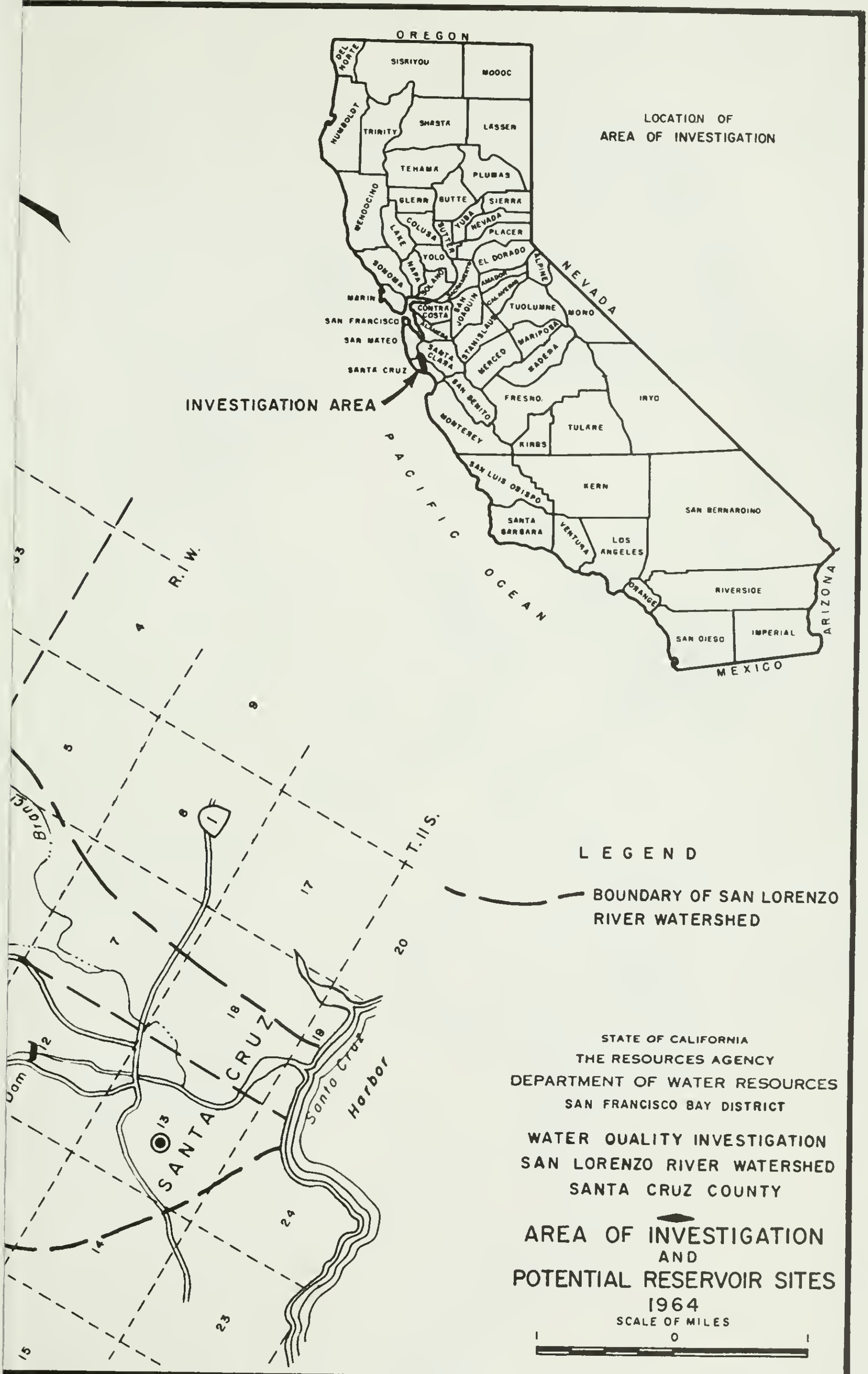
TABLE C3

ANALYSES OF GROUND WATER

SAN LORENZO RIVER WATERSHED - SANTA CRUZ COUNTY

Owner and use	State well number and other number	Date sampled	Temp in °F	Specific conductance (micromhos at 25° C)	pH	Mineral constituents in parts per million / equivalents per million: Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Carbonate (CO_3)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Nitrate (NO_3)	Fluoride (F)	Boron (B)	Silica (SiO_2)	Other constituents[d]	Total dissolved solids in ppm	Percent sodium	Hardness as $CaCO_3$: Total ppm	N.C. ppm	Analyzed by[c] D.W.R.
Spring (drains into Bear Creek)	9S/2W-16H	4-21-64		690	7.6	63 / 3.14	18 / 1.44	47 / 2.04	3.5 / 0.09	0 / 0.00	156 / 2.56	130 / 2.71	47 / 1.32	0.5 / 0.01		0.1		Fe 0.01; PO_4 0.18; ABS 0.0	429[b]	30	229	101	
Seep (drains into Boulder Creek)	-30B	1-14-64	51	432	8.0	42 / 2.10	16 / 1.32	19 / 0.83	1.4 / 0.04	0 / 0.00	165 / 2.70	34 / 0.71	23 / 0.65	9.8 / 0.16		0.0		ABS 0.0	242[b]	19	171	36	
Springs (drain into Newell Creek)	-34G	5-14-64	61	1,120	6.8					0 / 0.00	262 / 4.29		54 / 1.52	1.0 / 0.02				Fe 0.11; PO_4 0.31			525		
Kurt E. Fuhe garden irrigation	10S/1W-30K	1-16-64		621	7.3	55 / 2.74	26 / 2.18	31 / 1.35	2.8 / 0.07	0 / 0.00	128 / 2.10	167 / 3.48	20 / 0.56	2.5 / 0.04		0.0		Fe 2.2; ABS 0.0	400[b]	21	246	141	
Limestone Products Incorporated industrial	10S/2W-10F	12-11-63		81	6.9	7.3 / 0.36	0.7 / 0.06	7.7 / 0.33	0.6 / 0.02	0 / 0.00	30 / 0.49	2.8 / 0.06	5.3 / 0.15	1.9 / 0.03	0.2 / 0.01	0.05	31	Fe 0.00; ABS 0.0	72[a] 74[b]	43	21	0	
City of Santa Cruz municipal	11S/2W-12C well No. 1	10/59		355	6.8								24 / 0.68					Fe 1.2; Mn 0.29			126		

a. Determined by addition of constituents.
b. Gravimetric determination.
c. Analysis by U.S. Geological Survey, Quality of Water Branch (U.S.G.S.), Pacific Chemical Consultants (P.C.C.), or State Department of Water Resources (D.W.R.), as indicated.
d. Iron (Fe), Manganese (Mn), Total Phosphate (PO_4), and Alkyl Benzene Sulfonate detergent (ABS)


LOCATION OF
AREA OF INVESTIGATION
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
DEL NORTE
SISKIYOU
MODOC
HUMBOLDT
TRINITY
SHASTA
LASSEN
TEHAMA
PLUMAS
MENDOCINO
GLENN
BUTTE
SIERRA
LAKE
COLUSA
SUTTER
YUBA
NEVADA
PLACER
YOLO
EL DORADO
SONOMA
NAPA
SOLANO
ALPINE
AMADOR
MARIN
SACRAMENTO
CALAVERAS
TUOLUMNE
MONO
SAN FRANCISCO
CONTRA COSTA
SAN JOAQUIN
ALAMEDA
SAN MATEO
STANISLAUS
MARIPOSA
SANTA CLARA
MERCED
MADERA
SANTA CRUZ
SAN BENITO
FRESNO
INYO
MONTEREY
KINGS
TULARE
SAN LUIS OBISPO
KERN
SAN BERNARDINO
SANTA BARBARA
VENTURA
LOS ANGELES
ORANGE
RIVERSIDE
SAN DIEGO
IMPERIAL
INVESTIGATION AREA
R.I W.
T.II S.
SANTA CRUZ
Santa Cruz Harbor
LEGEND
BOUNDARY OF SAN LORENZO RIVER WATERSHED
STATE OF CALIFORNIA
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SAN FRANCISCO BAY DISTRICT
WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY
AREA OF INVESTIGATION
AND
POTENTIAL RESERVOIR SITES
1964
SCALE OF MILES
1 0 1


LOCATION OF
AREA OF INVESTIGATION
INVESTIGATION AREA
OREGON
NEVADA
ARIZONA
MEXICO
PACIFIC OCEAN
LEGEND
BOUNDARY OF SAN LORENZO RIVER WATERSHED
POTENTIAL ZAYANTE CREEK RESERVOIR SITE
POTENTIAL BEAR CREEK RESERVOIR SITE
POTENTIAL WATERMAN SWITCH RESERVOIR SITE
LOCH LOMOND (EXISTING)
SANTA CLARA CO
SANTA CRUZ CO
SAN MATEO CO
SANTA CRUZ CO
T. 9 S
T. 10 S
T. 11 S
T. 8 S
R. 3 W
R. 2 W
R. 1 W
Mountain Charlie Gulch
Zayante Creek
Lompico Creek
Lockhart Gulch
Bean Creek
Deer Creek
Bear Creek
Bear Creek Estates
Hopkins Gulch
Kings Creek
Two Bar Creek
Love Creek
Newell Creek
Waterman Switch
San Lorenzo Park
Riverside Grove
Boulder Creek
Boulder Creek
Azalea Dell
Olympia
Mt Hermon
Scotts Valley
Carbonera Creek
Branciforte Creek
Powder Mill Cr
Eagle Creek
Big Trees
SAN LORENZO RIVER
Ben Lomond
Marshall Cr
Alba Cr
Clear Creek
Felton
Fall Creek
Forest Park
Foreman Cr
Jamison Creek
Hare Creek
Check Dam
SANTA CRUZ
Santa Cruz Harbor
STATE OF CALIFORNIA
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SAN FRANCISCO BAY DISTRICT
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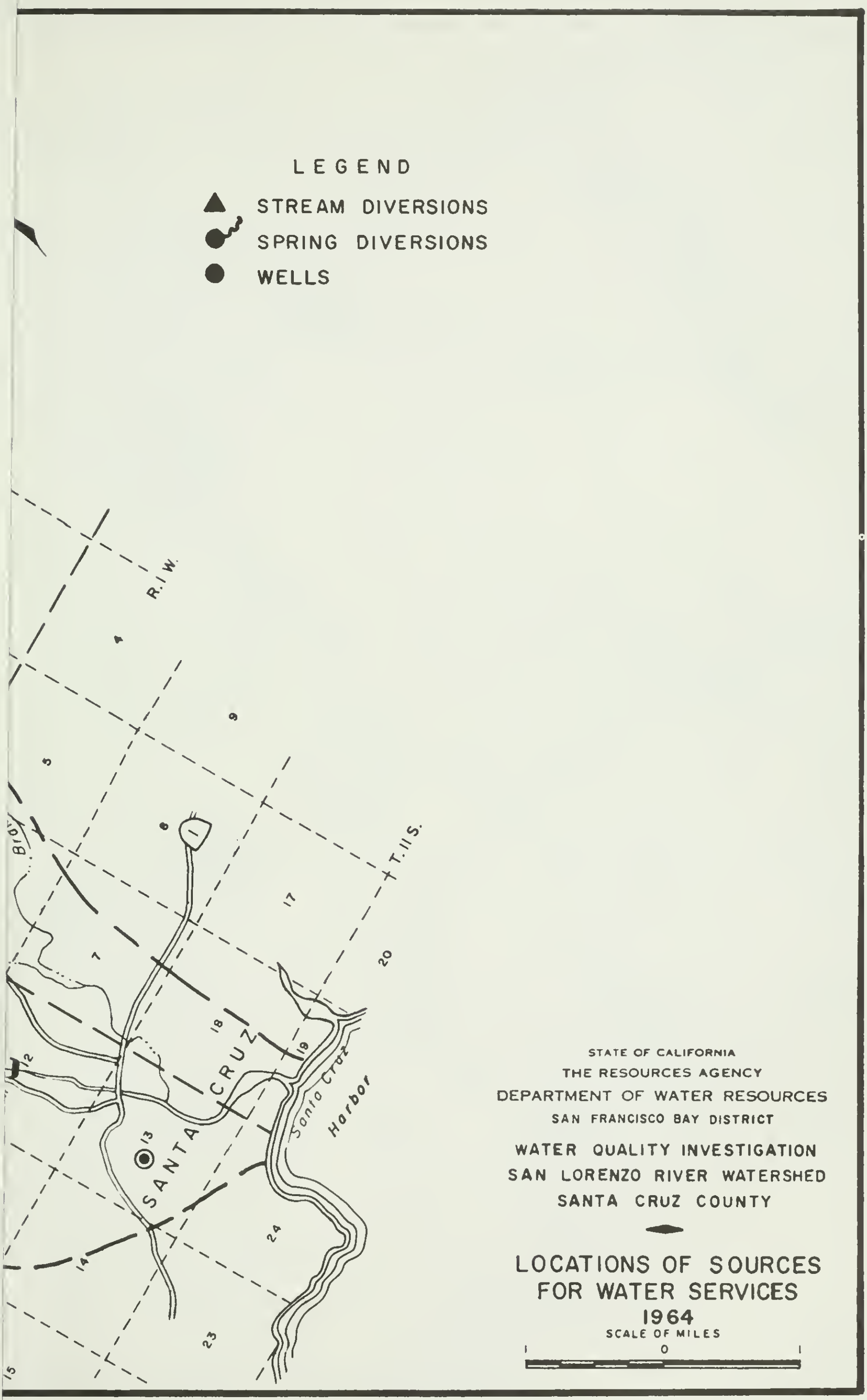
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY
AREA OF INVESTIGATION
AND
POTENTIAL RESERVOIR SITES
1964
SCALE OF MILES



STATE OF CALIFORNIA
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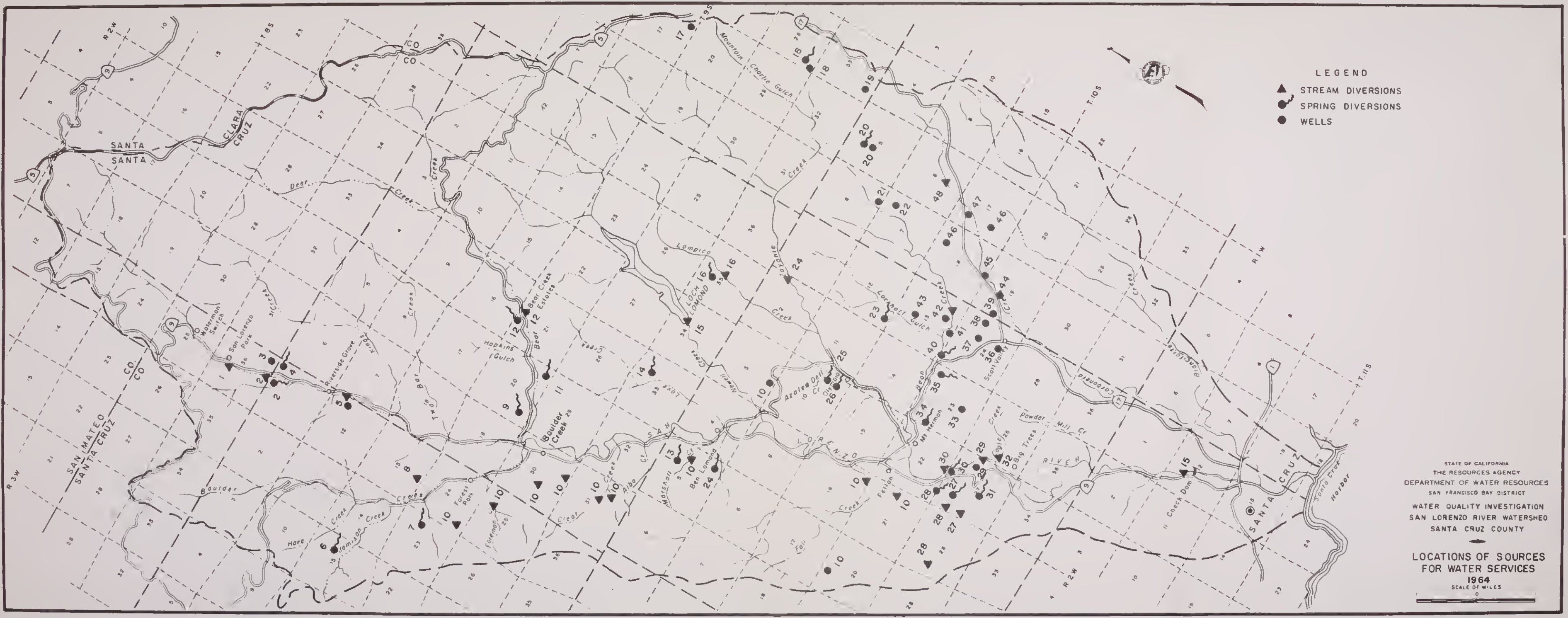
SAN FRANCISCO BAY DISTRICT

WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY

LOCATIONS OF SOURCES
FOR WATER SERVICES
1964


LEGEND
STREAM DIVERSIONS
SPRING DIVERSIONS
WELLS
STATE OF CALIFORNIA
THE RESOURCES AGENCY
DEPARTMENT OF WATER RESOURCES
SAN FRANCISCO BAY DISTRICT
WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY
LOCATIONS OF SOURCES FOR WATER SERVICES
1964
SCALE OF MILES
SANTA CLARA CO.
SANTA CRUZ CO.
SAN MATEO CO.
SANTA CRUZ CO.
SAN LORENZO RIVER
Boulder Creek
Ben Lomond
Felton
Mt. Hermon
Scotts Valley
Santa Cruz
Loch Lomond
Lompico
Zayante Creek
Bear Creek
Bear Creek Estates
Kings Creek
Hopkins Gulch
Deer Creek
Boulder Creek
Jamison Creek
Hare Creek
Forest Park
Brookdale
Riverside Grove
San Lorenzo Park
Waterman Switch
Azalea Dell
Olympia
Lockhart Gulch
Mountain Charlie Gulch
Bean Creek
Powder Mill Cr.
Carbonera
Branciforte
Big Trees
Eagle Creek
Fall Creek
Love Creek
Newell Creek
Marshall Creek
Alba Cr.
Clear Creek
Foreman Creek
Two Bar
Check Dam
Santa Cruz Harbor
R 3 W
R 2 W
R 1 W
T 8 S
T 10 S
T 11 S

LITHOLOGIC UNITS

QUATERNARY	RECENT	ESSENTIALLY WATER BEARING	Qal	RECENT ALLUVIUM UNCONSOLIDATED GRAVEL, SAND, SILT AND CLAY
QUATERNARY	RECENT	ESSENTIALLY WATER BEARING	Qls	LANDSLIDE DEPOSITS
QUATERNARY	PLEISTOCENE	ESSENTIALLY WATER BEARING	Qt	UNDIFFERENTIATED TERRACE DEPOSITS INCLUDES DISECTED OLDER ALLUVIUM AND MARINE TERRACE DEPOSITS
TERTIARY	PLIOCENE	ESSENTIALLY WATER BEARING / ESSENTIALLY NON-WATER BEARING	Pp	PURISIMA FORMATION COMPOSED MAINLY OF SANDSTONE, SILTSTONE AND SHALE. ONLY LOCALLY WATER BEARING
TERTIARY	MIOCENE	ESSENTIALLY WATER BEARING	Msm	SANTA MARGARITA FORMATION A UNIFORM MEDIUM TO COARSE FRIABLE SANDSTONE
TERTIARY	MIOCENE & OLDER	ESSENTIALLY NON-WATER BEARING	Tu	UNDIFFERENTIATED CONSOLIDATED SEDIMENTARY ROCKS INCLUDES THE BUTANO, SAN LORENZO, VAQUEROS, SANDHOLT & MONTEREY FORM
PRE-TERTIARY		ESSENTIALLY NON-WATER BEARING	gr	GRANITIC ROCKS CHIEFLY DEEPLY WEATHERED QUARTZ DIORITE AND GABBRO

SYMBOLS

DRAINAGE BASIN BOUNDARY

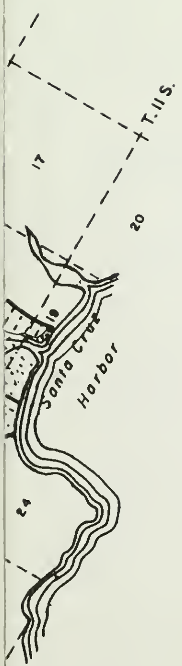
LITHOLOGIC CONTACT, DASHED WHERE APPROXIMATE

FAULT, LOCATION KNOWN

FAULT, LOCATION APPROXIMATE

FAULT, LOCATION INFERRED

NOTE— GEOLOGIC MAPPING ADAPTED FROM THOMAS W. DIBBLEE, JR



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SAN FRANCISCO BAY DISTRICT

WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY

AREAL GEOLOGY

SCALE OF MILES
1 0 1


LITHOLOGIC UNITS
PRE-TERTIARY
TERTIARY
QUATERNARY
MIOCENE & OLDER
MIOCENE
PLIOCENE
PLEISTOCENE
RECENT
ESSENTIALLY WATER BEARING
ESSENTIALLY NON-WATER BEARING
Qal RECENT ALLUVIUM
UNCONSOLIDATED GRAVEL, SAND, SILT AND CLAY
Qls LANDSLIDE DEPOSITS
Qt UNDIFFERENTIATED TERRACE DEPOSITS
INCLUDES DISECTED OLDER ALLUVIUM AND MARINE TERRACE DEPOSITS
Pp PURISIMA FORMATION
COMPOSED MAINLY OF SANDSTONE, SILTSTONE AND SHALE ONLY LOCALLY WATER BEARING
Msm SANTA MARGARITA FORMATION
A UNIFORM MEDIUM TO COARSE FRIABLE SANDSTONE
Tu UNDIFFERENTIATED CONSOLIDATED SEDIMENTARY ROCKS
INCLUDES THE BUTANO, SAN LORENZO, VAQUEROS, SANDHOLT & MONTEREY FORM
gr GRANITIC ROCKS
CHIEFLY DEEPLY WEATHERED QUARTZ DIORITE AND GABBRO
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SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY
AREAL GEOLOGY
SCALE OF MILES
SANTA CLARA CO
SANTA CRUZ CO
SAN MATEO CO
SANTA CRUZ CO
KINGS CREEK FAULT
BUTANO FAULT
ZAYANTE FAULT
BEN LOMOND FAULT
SANTA CRUZ
RIVER
Boulder Creek
Ben Lomond
Felton
T.9S.
T.10S.
T.11S.
R.1W.
R.2W.
R.3W.
Tu
Qal
Pp
Msm
Qt
gr


LEGEND
SURFACE WATER SAMPLING STATION
COLIFORM SAMPLING STATION
GROUND WATER SAMPLING STATION
R.1 W.
T.11 S.
SANTA CRUZ
Santa Cruz Harbor
34
35
36
13
STATE OF CALIFORNIA
THE RESOURCES AGENCY
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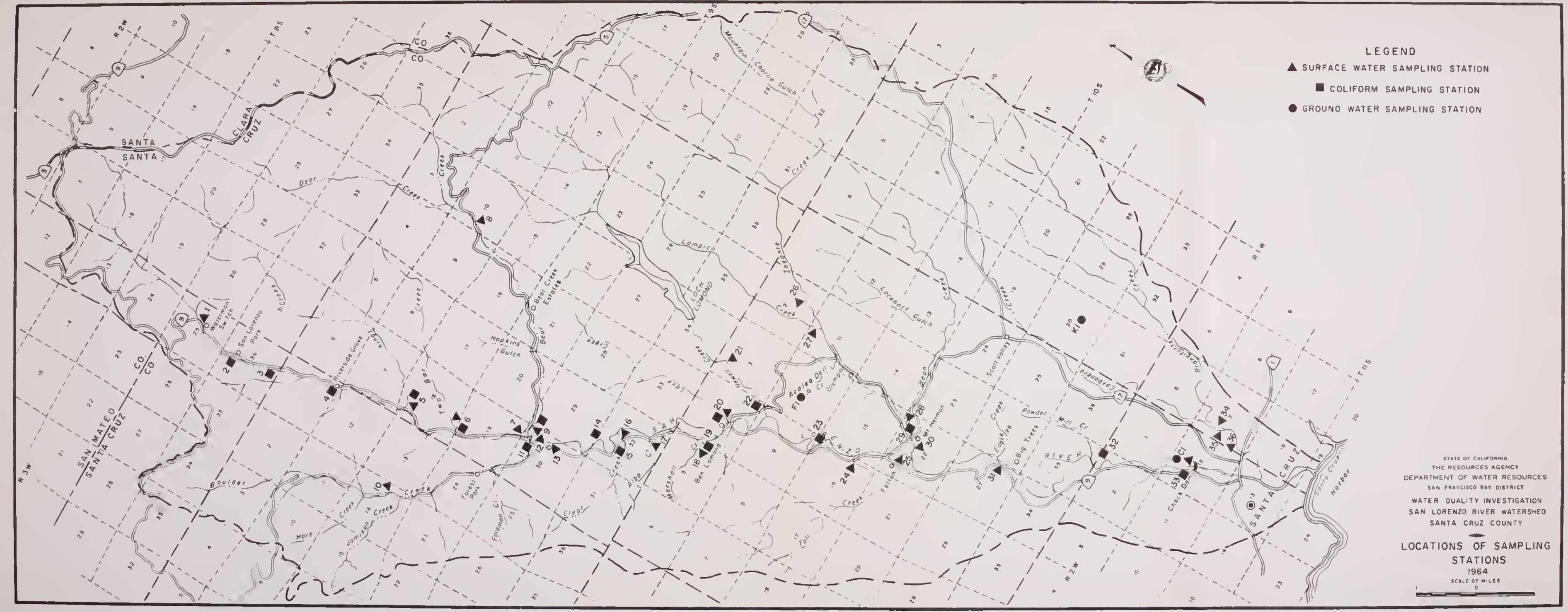
SAN FRANCISCO BAY DISTRICT
WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY
LOCATIONS OF SAMPLING STATIONS
1964
SCALE OF MILES
1 0 1



LEGEND
SURFACE WATER SAMPLING STATION
COLIFORM SAMPLING STATION
GROUND WATER SAMPLING STATION
STATE OF CALIFORNIA
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LOCATIONS OF SAMPLING STATIONS
1964
SCALE OF MILES
SANTA CLARA CO
SANTA CRUZ CO
SAN MATEO CO
SANTA CRUZ CO
SAN LORENZO RIVER
SANTA CRUZ
Loch Lomond
Ben Lomond
Felton
Boulder Creek
Zayante Creek
Lompico Creek
Bear Creek
Newell Creek
Mountain Charlie Gulch
Lockhart Gulch
Bean Creek
Scott Valley Creek
Carbonera Creek
Branciforte Creek
Powder Mill Cr
Eagle Creek
Kings Creek
Hare Creek
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Clear Creek
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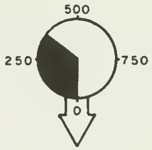
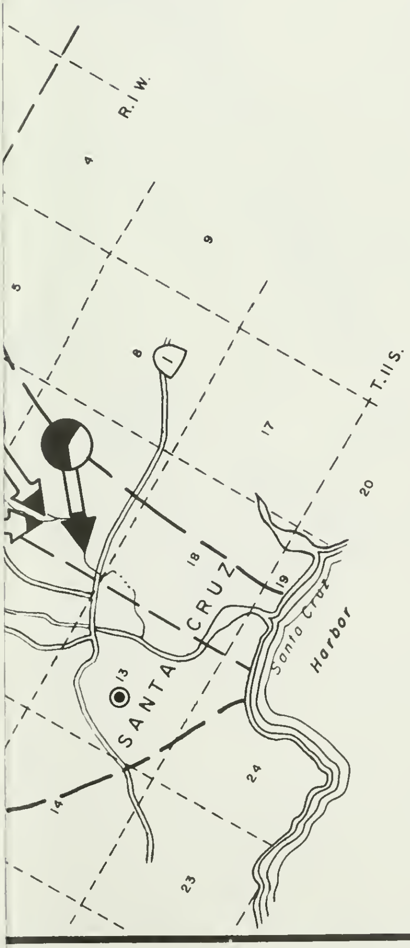
Forest Park
Azalea Dell
Olympia
Mt Hermon
Big Trees
Check Dam
Santa Cruz Harbor

LEGEND



SHADED PORTION OF CIRCLE INDICATES SPECIFIC CONDUCTANCE IN MICROMHOS AT 25°c

SHADED PORTION OF ARROW INDICATES FLOW IN CUBIC FEET PER SECOND



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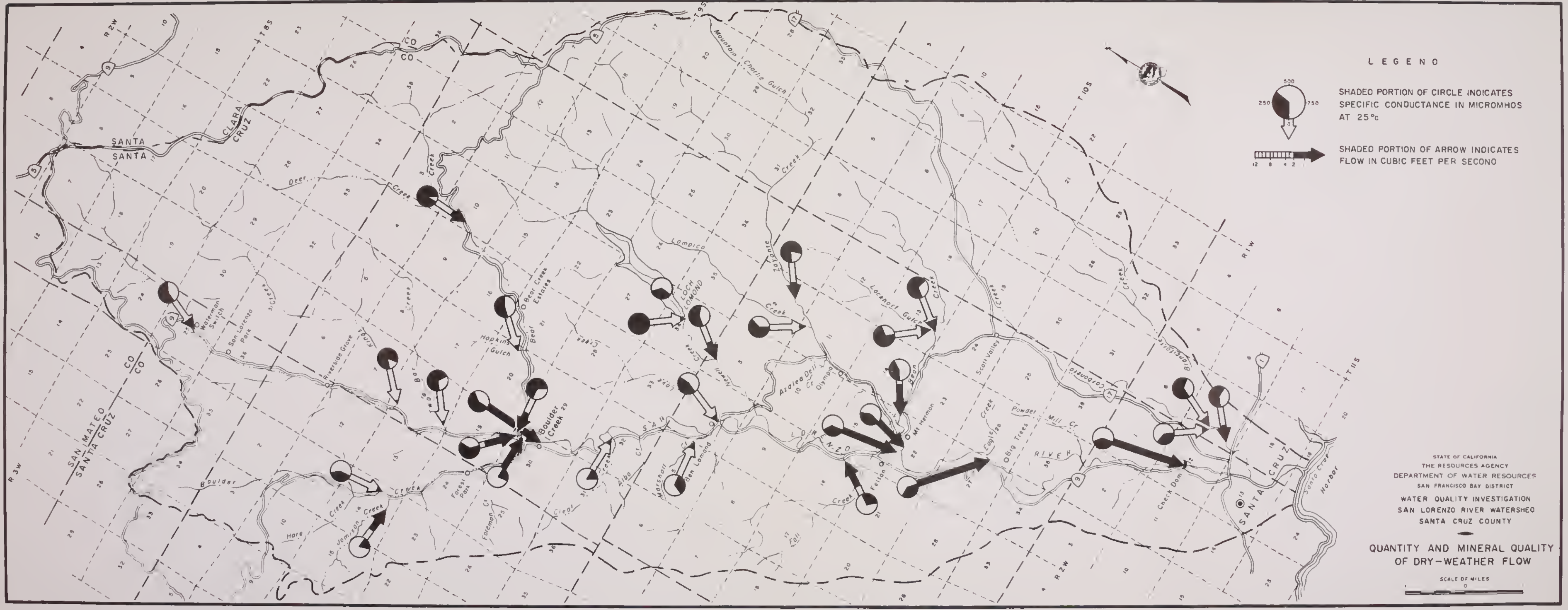
WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY

QUANTITY AND MINERAL QUALITY OF DRY-WEATHER FLOW

SCALE OF MILES

1 0 1


LEGEND
SHADED PORTION OF CIRCLE INDICATES SPECIFIC CONDUCTANCE IN MICROMHOS AT 25°c
500
250
750
0
SHADED PORTION OF ARROW INDICATES FLOW IN CUBIC FEET PER SECOND
12 8 4 2 1
STATE OF CALIFORNIA
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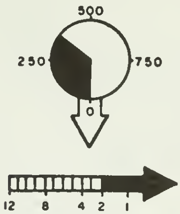
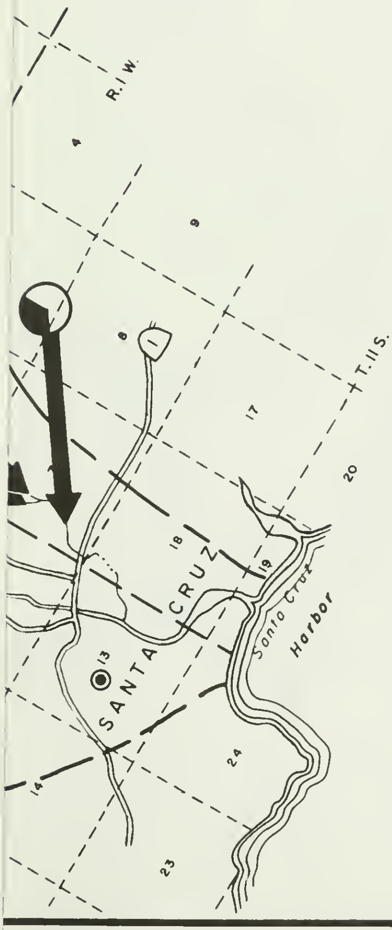
SAN FRANCISCO BAY DISTRICT
WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY
QUANTITY AND MINERAL QUALITY OF DRY-WEATHER FLOW
SCALE OF MILES
SANTA CLARA CO
SANTA CRUZ CO
SAN MATEO CO
SANTA CRUZ CO
Boulder Creek
Loch Lomond
Ben Lomond
Felton
Mt Hermon
Santa Cruz
Santa Cruz Harbor
Zayante Creek
Lompico Creek
Bear Creek
Kings Creek
Boulder Creek Estates
Lockhart Gulch
Bean Creek
Scott Valley Creek
Carbonera Creek
Branciforte Creek
Powder Mill Cr
Eagle Creek
Fall Creek
Newell Creek
Love Creek
Clear Creek
Jamison Creek
Hare Creek
Deer Creek
Two Bar Creek
Hopkins Gulch
Riverside Grove
San Lorenzo Park
Waterman Switch
Forest Park
Foreman Cr
Olympia
Azalea Dell Cr
Mountain Charlie Gulch
Big Trees
Check Dam
SAN LORENZO RIVER
R2W
R3W
R1W
T9S
T10S
T11S

L E G E N D



SHADED PORTION OF CIRCLE INDICATES SPECIFIC CONDUCTANCE IN MICROMHOS AT 25°c

SHADED PORTION OF ARROW INDICATES FLOW IN CUBIC FEET PER SECOND



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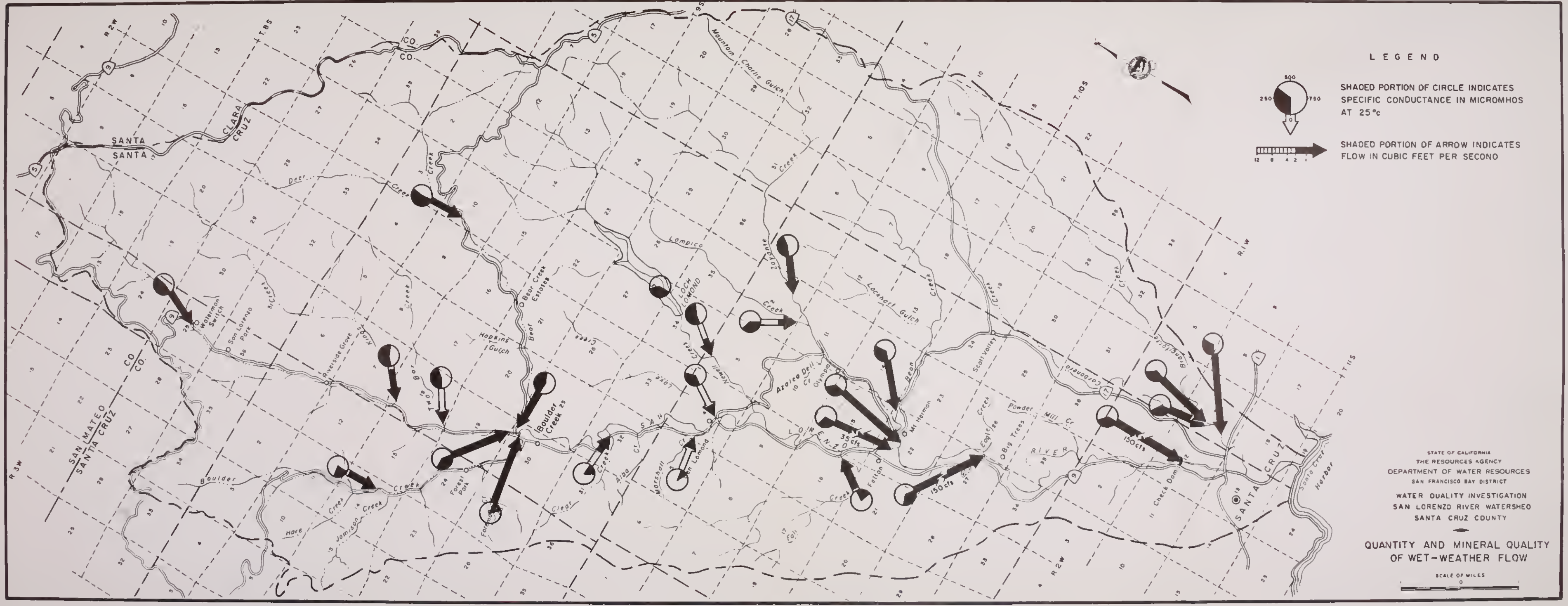
WATER QUALITY INVESTIGATION
SAN LORENZO RIVER WATERSHED
SANTA CRUZ COUNTY

QUANTITY AND MINERAL QUALITY OF WET-WEATHER FLOW

SCALE OF MILES
1 0 1


LEGEND
500
250
750
0
SHADED PORTION OF CIRCLE INDICATES SPECIFIC CONDUCTANCE IN MICROMHOS AT 25°c
12 8 4 2 1
SHADED PORTION OF ARROW INDICATES FLOW IN CUBIC FEET PER SECOND
STATE OF CALIFORNIA
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SANTA CRUZ COUNTY
QUANTITY AND MINERAL QUALITY OF WET-WEATHER FLOW
SCALE OF MILES
0
SANTA CLARA CO.
SANTA CRUZ CO.
SAN MATEO CO.
SANTA CRUZ CO.
R 3 W
R 2 W
R 1 W
T 8 S
T 9 S
T 10 S
T 11 S
Waterman Switch
San Lorenzo Park
Riverside Grove
Boulder Creek
Bear Creek Estates
Forest Park
Loch Lomond
Ben Lomond
Zayante
Olympia
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Santa Cruz
Santa Cruz Harbor
Deer Creek
Kings Creek
Hopkins Gulch
Bear Creek
Boulder Creek
Jamison Creek
Hare Creek
Clear Creek
Love Creek
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Lompico
Zayante Creek
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Lockhart Gulch
Bean Creek
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Carbonera Creek
Branciforte Creek
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Powder Mill Cr
Fall Creek
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Alba Cr
Two Bar Creek
Check Dam
SAN LORENZO RIVER
35 cfs
150 cfs
150 cfs